Space was not available to respond to each item in the Letters to the Editor that discussed my brief essay: GM Foods – Another View (Ap 16, 2001). For anyone interested in more extended comments, I have created this web site. The original essay appears at the end of my responses. For ease of reference, the original letters are in SMALL CAPS. My comments are in bold lower case within the original letter. Some points were made more than once. Responses in these cases are often in the “Footnotes” at the end.

Let me know if you feel some point has gone unanswered.

Danny Kohl

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LETTER FROM BETH CHAMPAGNE, EAST RYEGATE, VT.
Asian children do not need bioengineered Golden Rice to meet their Vitamin A requirement. As the World Bank has acknowledged in reviewing the Asian Nutrition Crisis, eating leafy greens daily does the job, cheaply and efficiently. That is exactly what Asian families had done for millennia, so why the Vitamin A deficiency crisis? It was the Green Revolution, which came from the United States in the sixties that destroyed families, access to a diversity of field.

I also would have guessed that the Green Revolution exacerbated the Vit A deficiency crisis. But the data seem to say otherwise. (See Table 1, below) The states in India where the Green Revolution had the largest impact tended to have a somewhat lower prevalence of Bitot’s Spot, a standard indicator of Vit A deficiency.

Its “miracle” rice (and Wheat) monocultures displaced cultivated greens from grain fields.

I do not have data at hand that address the question: Did the acreage of land planted to rice increase as a result of the Green Revolution. When I find those data, I will post them here. @

While its herbicides killed off the wild greens (“weeds”) traditionally harvested along with crops.
I also don’t have any data on the contribution of weeds to nutrition in Southeast Asia.

The arrival in a society of vitamin A deficiency, in itself the most easily and cheaply remedied of the deficiency diseases, in fact, supplementation is not cheap. See Footnote #1 signals environmental degradation and widespread poverty. GMOs will remedy neither.

I could not agree more. GMOs will certainly not end poverty. However, one product or another might make some contribution to better nutrition.

Food-based education projects, however, are already helping 3 million people in India combat vitamin A deficiency through home gardening and also by increasing diversity in their diets, to combat the malnutrition of which vitamin A is symptomatic.

I think it is wonderful that home gardening is helping so many people, even if it is only about 0.25% of the people estimated to be Vit A deficient (see Footnote #1). But it is not a zero sum game. For the most part, plant breeding, either conventional or using biotechnology, and home gardening projects are not competing for the same funds; for example, Swiss and European community plant biotech research funds that supported the Golden Rice project. The competition at those agencies was between support for an applied project, like Golden Rice, and basic research, say on details of the structure of the chromosome in Arabidopsis thaliana, a weed that has become the favored model system for plant biologists. Rockefeller Foundation also allocates a portion of its grants to breeding, whether it be conventional plant breeding or genetic engineering. One might argue that they would get more return on their money if they supported more projects like the home gardening project and spent less on breeding. Allocation problems are complex and there is always more than one opinion about relative priorities. (For one example, see Footnote #6)

Few are willing to acknowledge the role of science and technology in degrading the environment and impoverishing the multitudes. GMO technology epitomizes the contempt for life that is at the basis of both science and capitalism.

I come much closer to sharing Champagne’s view of capitalism than I do of science. I am glad for some of the accomplishments of science like penicillin, childhood vaccinations, the understanding and treatment of heart disease among others. These are substantial contributions to human welfare for an enterprise with contempt for life as its basis.

Note that in all cases, there are some risks. Some may decide that risk outweighs the potential benefit.

It also demonstrates the simplistic mode of cause-and-effect thinking that is based on complete disregard for, and ignorance of, the complex interdependencies that create and sustain life. We in the First World do indeed face a moral challenge, which is to acknowledge that in our contempt for life, in our refusal to acknowledge that we are constrained by its laws, and in our claim to be “conquering nature”, we are destroying humanity and nature, in effect cutting off the branch on which we sit. To restore ourselves and the earth, we would need to begin to learn from the indigenous peoples, who have not alienated themselves from life, and to conduct ourselves with respect for all life.

While it is clear that we face ecological challenges of immense proportions which capitalism and its devotion to the short run bottom line are ill equipped to respond to, might Champagne’s rhetoric include just a bit of romanticization of the lives and practices of indigenous peoples?
LETTER FROM CHARLES MARGULIS, GREENPEACE

GENETIC ENGINEERING CAMPAIGN, BALTIMORE

WHEN TWENTY-THREE AFRICAN DELEGATES TO A UNITED NATIONS CONFERENCE SAW IMAGES OF STARVING AFRICAN CHILDREN USED IN MONSANTO ADS CLAIMING THAT GENETIC ENGINEERING IS CRITICAL TO FEED THE POOR, THEY WROTE IN RESPONSE, “WE STRONGLY OBJECT THAT THE IMAGE OF THE POOR AND HUNGRY FROM OUR COUNTRIES ARE BEING USED BY GIANT MULTINATIONAL CORPORATIONS TO PUSH A TECHNOLOGY THAT IS NEITHER SAFE, ENVIRONMENT FRIENDLY, NOR ECONOMICALLY BENEFICIAL TO US. WE DO NOT BELIEVE THAT SUCH COMPANIES OR GENE TECHNOLOGIES WILL HELP OUR FARMERS TO PRODUCE THE FOOD THAT IS NEEDED IN THE 21ST CENTURY. ON THE CONTRARY, WE THINK IT WILL DESTROY THE DIVERSITY, THE LOCAL KNOWLEDGE AND THE SUSTAINABLE AGRICULTURAL SYSTEMS THAT OUR FARMERS HAVE DEVELOPED FOR MILLENNIA AND THAT IT WILL THUS UNDERMINE OUR CAPACITY TO FEED OURSELVES”.

It is certainly for Africans to decide what shall happen in Africa. It is not surprising that Africans do not speak with one voice. A number of African scientists and policy makers have said loudly that Africans should make the choice of technology, and should be able to choose agricultural biotechnology, e.g., the agricultural minister of Nigeria and Florence Wambugu, a Kenyan agricultural researcher. See Footnote #2 for their statements. While they tend to be more optimistic than I am about the magnitude of the contribution which biotechnology can make, their views are certainly interesting.

WRITING SPECIFICALLY ABOUT THE SO-CALLED GOLDEN RICE, THE ETHIOPIAN DELEGATE AND SPOKESPERSON FOR THE DEVELOPING WORLD AT THE INTERNATIONAL NEGOTIATIONS ON GENETICALLY ENGINEERED FOOD, DR. TEWOLDE EGZIABHER STATED, “IT IS IMMORAL TO USE ONE GROUP’S WEAKNESS TO SELL A PRODUCT TO ANOTHER GROUP”.

I could not agree more that the biotech industry has used shameful advertising to tout biotechnology. But this has nothing to do with the empirical question of whether or not Golden Rice and other specific biotechnology products can make a contribution to better nutrition in regions where rice is a staple. A better bet for making important contributions is the work on engineering viral resistance into subsistence crops like sweet potatoes and cassava.

Had Margulis quoted more of Dr. Egziabher’s statement, the reader would know that Dr. Egziabher does not categorically rule out a role for biotechnology. In the very same sentence he writes, “Though technological inputs have a role to play in rural development, and genetic engineering could be a technology to consider, it would remain but one technology among many.” No argument from me there. Dr. Egziabher then goes on to make it clear that increased productivity, no matter how it is achieved, is just the beginning. “For example even if potential yields of food crops were to be dramatically improved, if storage, transportation, marketing, distribution, and the ability to buy the food were not simultaneously improved, the effort would still remain ineffective. In fact, as we keep pointing out, it is not shortage of food that is the problem, but it’s distribution. More GE food is not the point: it is improving access and local food security.” Again, I could not agree more. However, increasing access to calories by developing viral resistance in subsistence crops may lead more directly to benefits to poor rural communities than improving the yield of cash crops.
DANNY KOHL SAYS YELLOW RICE COMES FROM A TEAM OF SCIENTISTS WHOSE SOLE INTENT IS TO BRING IT FREELY TO THE POOR. IN FACT, THE LEAD SCIENTIST ON THIS TEAM IS A FORMER NOVARTIS RESEARCHER WHO CURRENTLY HOLDS AN INTEREST IN DOZENS OF NOVARTIS PLANT PATENTS.

Assume this is true. What does it have to do with that scientist’s work on golden rice? His past history might reasonably raise warning flags, but after a thorough investigation, Margulis would find out that the scientists involved have acted to implement the goal of making seed available to poor farmers without profit to any multinational or to themselves, just as they said they would.

Ingo Potrykus, one of the two lead scientists on the project, gives a detailed account in readable form in the scientific journal, Plant Physiology <http://www.plantphysiol.org/cgi/content/full/125/3/1157?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&author1=Potrykus&searchid=QID_NOT_SET&stored_search=&FIRSTINDEX=0&fdate=1/1/2000> If you want to see it and can’t get access to it on the web, let me know and I will email it to you. A relatively short excerpt is included as Footnote #3

DESPITE BEING DEVELOPED WITH PUBLIC MONEY, NOVARTIS (THROUGH SYNGENTA, A COMPANY IT FORMED IN ALLIANCE WITH ANOTHER GENE GIANT, ZENEC) HOLDS THE RIGHTS TO SELL THE RICE, AND A COMPANY SPOKESPERSON TOLD THE FINANCIAL TIMES, “WE SEE IT DOING PARTICULARLY WELL IN JAPAN.” Actually it is Zeneca. But the mergers and rearrangements are so rapid, who can keep track. Margulis might have added that Zeneca has the rights to sell golden rice only in the first world. In return for being granted that right, Zeneca took on the formidable task of obtaining waivers of the 70 intellectual property rights agreements which otherwise would have restricted free distribution of seed. This is a task that would have been very difficult, if not impossible, for the scientists to achieve on their own. I find it an acceptable trade-off. See Footnote #3

THE RURAL ADVANCEMENT FOUNDATION INTERNATIONAL, WHICH WORKS WITH SMALL FARMERS WORLDWIDE, RIGHTLY EXPOSED THIS RIP-OFF AS “MILLIONS OF DOLLARS OF PUBLIC FUNDING [BEING] SURRENDERED TO A MULTINATIONAL CORPORATION.” See Footnote #4 for a discussion of the larger question of how the public might claim its share of the profit made possible by public investment.

SCIENTISTS HAVE FOUND YELLOW RICE AN UNLIKELY SOLUTION TO THE PROBLEM IT PRETENDS TO ADDRESS. DR. MARION NESTLE HAS WRITTEN IN THE JOURNAL OF THE AMERICAN DIETETIC ASSOCIATION, "FOOD-BASED APPROACHES TO IMPROVING VITAMIN A STATUS SEEM ESPECIALLY DESIRABLE. THE ADDITION OF A ONE OR TWO NUTRIENTS TO AN EXISTING FOOD DOES NOT CONSTITUTE A FOOD-BASED APPROACH.”

THE REAL PROBLEM THE INDUSTRY SEEKS TO ADDRESS IS NOT MALNUTRITION BUT PUBLIC OPINION. I could not agree more. And to add insult to injury, the industry made no contribution to the success of the difficult scientific undertaking that produced golden rice. But what has this got to do with the potential usefulness of Golden Rice for the uses we care about?

THE PROPAGANDA VALUE OF THE YELLOW RICE FOR THE INDUSTRY HAS BEEN IMMEASURABLE, AS THEY HAVE SHAMELESSLY USED IT IN AN ATTEMPT TO QUELL GROWING US DISTRUST OF ITS EXPERIMENTAL FOODS. AN EXECUTIVE FROM SYNGENTA ADMITTED THE PUBLIC RELATIONS VALUE OF THE PROJECT WHEN HE TOLD
THE ST. LOUIS POST-DISPATCH THAT “GOLDEN RICE” WAS A BADLY NEEDED POSITIVE MESSAGE FOR THE INDUSTRY. FACED WITH A PUBLIC RELATIONS MELTDOWN, THE BIOTECH/CHEMICAL INDUSTRY IS DESPERATELY PLYING THE SAME MESSAGE IT PROMOTED WHEN ITS PESTICIDES WERE FIRST EXPOSED AS THREATS TO THE ENVIRONMENT AND OUR HEALTH.

I agree entirely.

WHEN RACHEL CARSON’S SILENT SPRING BROUGHT THE DANGERS OF DDT TO A NATIONAL AUDIENCE, THE CHEMICAL INDUSTRY RESPONDED WITH A PUBLIC RELATIONS BLITZ CENTERED AROUND ITS CLAIM THAT POOR PEOPLE WOULD STARVE WITHOUT PESTICIDES.

The evaluation of the contribution of pesticides (and there are more pesticides than DDT) in agriculture is too large a subject to be evaluated here. But, by and large, people are hungry because they are poor and cannot afford to buy available food, not because there is not enough food.

MONSANTO, ONE OF THE LEADING CHEMICAL POLLUTERS OF THE LAST CENTURY AND A COMPANY KNOWN FOR COVERING UP EVIDENCE OF THE DANGERS OF ITS PRODUCTS (SEE WWW.CHEMICALINDUSTRYARCHIVES.ORG/DIRTYSECRETS/ANNISTON/1.ASP) IS TODAY THE LEADING FORCE BEHIND THE GENETIC ENGINEERING OF OUR FOOD. WHILE PROponents OF THIS NEW FOOD EXPERIMENT DISTRACT US WITH UNSUBSTANTIATED ARGUMENTS ABOUT FUTURE WONDERS, AMERICANS ARE CURRENTLY EATING MONSANTO’S GENETICALLY ENGINEERED CROPS IN THOUSANDS OF FOODS ON OUR SUPERMARKET SHELVES. LIKE MONSANTO’S CHEMICALS, NONE OF THESE ALTERED FOODS HAVE BEEN SUBJECT TO LONG-TERM STUDY FOR THEIR EFFECT ON OUR HEALTH OR THE ENVIRONMENT.

LIKE OTHER APOLOGISTS FOR THIS INDUSTRY,

Well, that is one way to end a discussion.

KOHL ARGUES THAT ECONOMIC AND POLITICAL SOLUTIONS TO PROBLEMS OF HUNGER “WILL NOT HAPPEN SOON”,

Does Margulis really believe there is a strategy for the rapid solution to problems of distributive justice? Does he propose we do nothing until that desirable goal is reached?

IMPLYING THAT IT IS FASTER, EASIER AND SAFER TO ALTER MILLIONS OF YEARS OF EVOLUTIONARY ECOLOGY THAN TO ADDRESS THE MANMADE INEQUALITIES THAT HAVE BEEN PERPETRATED OVER THE PAST FEW DECADES.

#See Note #5 for a brief discussion of risk reduction

BUT YELLOW RICE HAS BEEN IN DEVELOPMENT FOR NEARLY TEN YEARS, AND ACCORDING TO ITS DEVELOPERS IS STILL SEVERAL YEARS AWAY FROM EVEN SMALL FIELD TRIALS. AFTER MORE YEARS OF RESEARCH AND MILLIONS OF DOLLARS, WHAT WILL THESE RESEARCHERS ACHIEVE? THEY DON’T KNOW, BUT THEY HOpe THE RICE MIGHT HAVE BETA CAROTENE THAT HUMANS CAN ASSIMILATE, IN QUANTITIES THAT MATTER, WITHOUT SIDE-EFFECTS THAT HARM THE ENVIRONMENT OR HUMAN HEALTH.

Obviously, the pace of research and development is not to Margulis’ liking. But that is a typical time scale for crop improvement. No one claimed it was easy.

MEANWHILE, EVERY YEAR AND DOLLAR SPENT ON THIS RICE IS A YEAR AND DOLLAR NOT SPENT ON PROJECTS THAT TRULY ADDRESS SUSTAINABLE SOLUTIONS TO POVERTY AND HUNGER.

This is not the case. In general, such projects are not competing for the same funds. Swiss and European community funds earmarked for plant biotech research are not available to the sorts of projects Margulis favors. (For a brief discussion of priorities in allocation funds, see Note 6)

WITHOUT THE ENVIRONMENTAL AND HUMAN HEALTH RISKS OF GENETICALLY ENGINEERED FOOD.
See note 5 for a brief discussion of risk reduction.

CHARLES MARGULIS
GREENPEACE GENETIC ENGINEERING CAMPAIGN

LETTER FROM BRIAN TOKAR, BIOTECHNOLOGY PROJECT DIRECTOR,
INSTITUTE FOR SOCIAL ECOLOGY, PLAINFIELD, VT.

PROFESSOR KOHL IS RIGHT ABOUT ONE THING: CORPORATE CONTROL OVER
AGRICULTURE AND OVER SCIENTIFIC RESEARCH AGENDAS IS PERHAPS THE MOST
IMPORTANT ISSUE UNDERLYING THE DEBATES OVER GENETICALLY ENGINEERED FOOD.

Thank you. For one alarming way, which was new to me, that corporations
influence the research agenda see the first dozen lines in Note #3.

BUT HAVING ACKNOWLEDGED THIS, HE THEN PROCEEDS TO OUTLINE A RESEARCH
AGENDA THAT SEEMS TAILOR-MADE TO BENEFIT HIS CORPORATE BENEFACCTORS.

It is hard to stick to the argument, without lacing rhetoric with insult, isn’t it?
CERTAINLY THERE IS A GREAT DEAL OF SCIENTIFIC KNOWLEDGE TO BE BROUGHT TO
BEAR ON THE PROBLEMS OF HUNGER AND MALNUTRITION IN THE WORLD. BUT WHY IS
THE QUESTION ALWAYS “HOW CAN WE ADDRESS THESE PROBLEMS THROUGH GENETIC
ENGINEERING?” AND ALMOST NEVER “WHAT IS THE MOST APPROPRIATE COURSE OF
SCIENTIFIC RESEARCH TO ADDRESS HUMAN NEEDS?”

The latter is clearly the appropriate question. Surely there should be a mix of
approaches. How to get a better balance is a difficult question. There are fads
in science and doing some kinds of science is more glamorous and brings more
prestige than doing other types. I am glad for the successes Tokar mentions
below. But there are some things that have not yielded to conventional
approaches and for which genetic engineering may hold the most promise. One
example may be the need to develop cassava cultivars resistance to viruses that
have a huge negative impact on the yield of this subsistence crop. No
corporation will undertake this research since there is no profit potential in a
successful outcome. There is some history of corporations being willing to train
Third World scientists of which I am aware. For example, Dr. Wambugu
mentions that she was trained at Monsanto. See Footnote #2, the second portion.

A group within the Donald Danforth Plant Research Center focuses on plant
viruses and the training of African scientists in molecular biology with the aim
of these scientists continuing to work on this important plant pathogens on
their return to Africa. The interests of this group range from disease diagnostics
to control and will include taxonomy, biology, and epidemiology of plant
viruses. You will note that both of the examples are from St. Louis. (My
apologies for being so provincial.) One of the main points I tried to make in my
essay is the need to find formats which would allow scientists to bring the
power of modern science to bear on the orphan diseases and crops. While there
are some examples of foundations and not-for-profit Centers doing this sort of
thing, much more needs to be done. Some ideas in this regards are discussed in
Footnote #2.

A FEBRUARY 3 ARTICLE IN THE BRITISH MAGAZINE NEW SCIENTIST OFFERED A VERY
DIFFERENT APPROACH TO USING SCIENCE TO AID THE WORLD’S POOR. USING AN
IMPRESSIVE ARRAY OF VERY LOW-TECH INTERVENTIONS—TRAP CROPS FOR COMMON
PESTS, POLYCULTURES REPLACING MONOCULTURES, CHANGING PLANTING TIMES AND
PATTERNS, ETC.—FARMERS IN AFRICA HAVE BEEN INCREASING YIELDS BY UP TO 100
PERCENT. THAT’S A HUGE ADVANCE BEYOND THE MARGINAL-YIELD ADVANTAGES
THAT MONSANTO AND THE OTHER BIOTECH COMPANIES BRAG ABOUT INCESSANTLY.

Again, I applaud these successes. But there is no need for it to be "Either/or".
THE BIOTECH INDUSTRY SUPPORTED THE DEVELOPMENT OF “GOLDEN” VITAMIN A RICE TO THE TUNE OF $100 MILLION.

Wrong. The biotech industry did not provide any funds to support the science that resulted in Golden Rice. The $100 million may be the entire amount that Rockefeller has spent on rice improvement over many years. I am not certain that this correct.

Even if the beta carotene content could someday be increased fivefold, as Kohl suggests, it will still take 3 or 4 pounds of rice a day to satisfy a person’s nutritional requirements, and that is only if other nutrients are in proper balance. There’s much more beta carotene to be (had) in traditional crops, from leafy green vegetables to squashes, melons and mangoes.

Since others commented on these points, it is discussed briefly in “Note 7”

The key is helping people regain the ability to feed themselves, exactly what the companies that have brought us genetic engineering are most threatened by.

This may be true, but what has it got to do with the potential usefulness of Golden Rice? Rice will continue to be a major source of calories for a large number of people. It is better if it contains micronutrients as well as calories.

In emergencies, vitamin A supplements are available for just a few pennies.

Biotechnology does offer one clear advantage (to corporations) over more traditional low-tech solutions:

It is not cheap. See Footnote #1

The ability to “invent” new varieties of plants and animals that companies like Monsanto can patent and claim proprietary rights over.

This is not the case with Golden Rice. And, as I have suggested, while it remains an open question of whether Golden Rice will be capable of making a significant contribution to better nutrition, its organizational format allowed the scientists to work on a problem that had no profit potential. The way this was done might serve as one model for freeing science from the iron grip of corporate choice of projects based on profit potential.

While the results of more traditional agricultural research often remain in the public domain—where it properly belongs—genetically engineered varieties are subject to the most stringent "intellectual property" rules of the WTO.

I doubt that the results of agricultural research using more traditional tools are any more apt to be in the public domain. No matter how the commercial varieties are produced, seed companies have always tried to protect their proprietary interest in the variety. Nothing about varieties produced by biotechnology has increased seed companies’ attempt to do so.

Farmers all over North America are finding this out the hard way, as they face severe legal penalties even when their crops are contaminated with Monsanto’s proprietary genes due to cross-pollination.

Apparently, Tokar is referring to the dispute between Percy Schmeiser, a Canadian farmer, and Monsanto. Schmeiser asserted that the plants containing Monsanto’s patented gene got onto his land from wind blown pollen. The St. Louis Post-Dispatch reported that “Judge W. Andrew MacKay expressed doubts about Schmeiser's contentions but did not rule directly about the source of the
Nonetheless, the judge ordered Schmeiser to pay Monsanto $15,450 in technology fees and $105,000, the profit Schmeiser made on the crop.

See Footnote # 8 for a copy of the St. Louis Post-Dispatch story on the case and websites to other reports.

I would be comfortable if the ruling was based on a farmer’s deliberate violation of the agreement signed when purchasing seed. But in the absence of such a finding, it is a frightening outcome. One would assume that it will be litigated in a US jurisdiction.

FOR TWENTY FIVE YEARS, THE NARROW AGENDA OF GENETIC ENGINEERING HAS DOMINATED SCIENTIFIC DISCUSSIONS IN THE PUBLIC AND PRIVATE DOMAINS, CORRUPTING SCIENTIFIC DISCOURSE WHILE ENRICHING THOSE RESEARCHERS WHO ARE MOST WILLING TO FEED AT THE CORPORATE TROUGH.

For better or worse, there is very little money in the corporate trough for scientists not working within the corporation. By far the largest fraction of the funds for academic science come from government sources. And most of that is for basic, not applied, research. The part of my work supported by Monsanto funds is aimed at understanding mechanisms of the response of biological nitrogen fixation to mild drought stress. The impact of corporations on funds for public research is more subtle than Tokar’s remark suggests. About 2/3 of money spent on research is spent by the private sector. These results are not published. A significant fraction of PhDs in Plant Biology goes to work for corporations. They have to have the technical skills which corporate projects require. For this and other reasons – one being the faddishness and glamour of molecular biology, we are turning out PhDs with a very powerful tool kit. Many plant biologists are worried that not enough emphasis was placed on biochemistry and evolutionary relationships to allow these young scientists to recognize the most important problem to apply their skills to.

Another example comes from the article by Ingo Potrykus quoted at greater length in Footnote #3; namely, The framework [IV and V] of European Union [EU] funding forces public research into coalitions with industry and thus is responsible for two very questionable consequences: Public research is oriented toward problems of interest to industry, and public research is losing its independence.

IT IS TIME FOR A MUCH MORE HONEST DISCUSSION OF HOW SCIENCE CAN BEST BENEFIT HUMAN HEALTH AND WELL BEING.

My sentiments exactly. The absence of personal attacks with no foundation except for disagreement might make a small contribution to a more honest discussion.

BRIAN TOKAR
BIOTECHNOLOGY PROJECT DIRECTOR
INSTITUTE FOR SOCIAL ECOLOGY

LETTER FROM PETER M. ROSSET, FOOD FIRST/INSTITUTE FOR FOOD AND DEVELOPMENT POLICY, WWW.FOODFIRST.ORG, OAKLAND, CALIF.

DANNY KOHL’S SUGGESTION THAT GENETICALLY ALTERED “GOLDEN” RICE IS THE ANSWER FOR THE CONDITION OF 2 MILLION CHILDREN AT RISK OF VITAMIN A DEFICIENCY-INDUCED BLINDNESS REVEALS A TREMENDOUS NAÏVETÉ ABOUT THE REALITY AND CAUSES OF VITAMIN AND MICRO-NUTRIENT MALNUTRITION.
I would indeed be naïve if I thought that Golden Rice was THE solution for children at risk. It is so much easier to argue against a self-constructed straw man. In my view, at best, Golden Rice may be able to contribute to ameliorating Vit A deficiency. (Nutrition is not a matter of “all or none.” See Footnote #7)

VITAMIN A DEFICIENCY IS NOT A PROBLEM BUT RATHER A SYMPTOM.

I would argue it is both. And I think it is a good thing if the more narrowly defined problem can be ameliorated while the larger problem is being worked on. This is the case, for example, with the fortification of salt with iodine and the promising fortification of rice with iron. Whether Golden Rice can make a contribution is an empirical question whose answer will not be known for some years.

A WARNING SIGN OF BROADER DIETARY INADEQUACIES ASSOCIATED WITH POVERTY AND WITH AGRICULTURAL CHANGE FROM DIVERSE CROPPING SYSTEMS TOWARD RICE MONOCULTURE. PEOPLE DO NOT HAVE VITAMIN A DEFICIENCY BECAUSE RICE CONTAINS TOO LITTLE VITAMIN A BUT BECAUSE THEIR DIET HAS BEEN REDUCED TO RICE AND ALMOST NOTHING ELSE, AND THEY SUFFER MANY OTHER DIETARY ILLNESSES THAT COULD BE ADDRESSED BY A MORE VARIED DIET.

No argument from me.

A MAGIC-BULLET SOLUTION THAT PUTS BETA-CAROTENE INTO RICE˜WITH POTENTIAL HEALTH AND ECOLOGICAL HAZARDS

I assume Rossett did not supply evidence for the assertion of health hazards do to space limitations. Since I do not know what he is referring to, I have no comment. I can make an educated guess about the basis for the assertion of environmental hazards and have commented on them in Footnote #5.

˜WHILE LEAVING POVERTY, POOR DIETS AND EXTENSIVE MONOCULTURE INTACT, IS UNLIKELY TO MAKE ANY DURABLE CONTRIBUTION TO WELL-BEING.

As I have said above, it is possible to make some improvements before achieving the desirable goal of social and distributive justice. I offered as one example the iodination of salt.

KOHL ARGUES THAT THE DEVELOPMENT OF GOLDEN RICE WAS “SUPPORTED ENTIRELY BY THE PUBLIC SECTOR AND PHILANTHROPIC FUNDS.” HE FAILS TO MENTION THAT ALL RIGHTS HAVE BEEN GRANTED TO CORPORATE GIANT ASTRA ZENeca, WHO PLANS TO MARKET IT IN INDUSTRIALIZED COUNTRIES AS A ”NUTRACEUTICAL “ (FOOD ITEM CONTAINING A PHARMACEUTICAL AGENT),

Rossett is correct. I did leave out, among many other things, the agreement with Zeneca. Since it was brought up by others, a portion of an article on the subject by one of the lead scientists in the Golden Rice project, Ingo Potrykus, is included as Footnote #3.

WHILE MAKING IT AVAILABLE FREE OF EXTRA CHARGES ABOVE NORMAL PURCHASED IMPROVED SEED COSTS TO THOSE POOR FARMERS IN THE THIRD WORLD WHO CAN DEMONSTRATE THAT THEIR ANNUAL RICE SALES ARE BELOW A MAGIC THRESHOLD ($5000 WAS SUGGESTED). SHOULD THEY BRING THEIR TAX RETURNS TO THE SEED SHOP TO PROVE THIS? OF COURSE MOST PEASANT FARMERS HAVE NEVER PAID TAXES IN THEIR LIFE, AND PROBABLY DON’T EVEN HAVE AN IDENTITY CARD OR PROPER TITLE TO THEIR LAND. NOR DO THE USUALLY BUY EXPENSIVE SEEDS, PREFERING TO SAVE THEIR OWN FOR THE NEXT PLANTING. WHO WOULD ADMINISTER THIS ANYWAY?

The International Rice Research Institute in the Philippines, a nonprofit charged with working on agricultural issues of relevance to poor farmers in the Third World found a way of distributing Green Revolution seed (and there are some who wished that they had been unable to do so.) I imagine they can find a way. Gary Toenniessen of the Rockefeller Foundation gives a more definitive answer in the last paragraph of his report, "Vitamin A Deficiency and Golden Rice: The Role of the Rockefeller Foundation", available on the web at
LETTER FROM MARTIN TEITE, COUNCIL FOR RESPONSIBLE GENETICS
CAMBRIDGE, MASS.

DANNY KOHL’S CALL TO SEPARATE IDEOLOGY FROM SCIENCE OR EMPIRICISM ISN’T POSSIBLE OR DESIRABLE. ALL SCIENCE OCCURS IN A CONTEXT; NO EMPIRICISM IS FREE FROM IDEOLOGY. BIOTECHNOLOGY IS NO MORE VALUE FREE THAN NUCLEAR POWER OR AUTOMOBILE TECHNOLOGY.

Teite is absolutely correct. All science is done within a context. This context often makes itself felt in the choice of the problem to be investigated. I should have been clearer. By ideological opponents of biotechnology I meant those who reflexively reject it because it is biotechnology. Among the opponents of biotechnology, I would include among ideological opponents those who are opposed to “altering nature”. Other opponents would require that biotechnology be absolutely risk free before considering whether to support one product or another. Since nothing is risk free, such an opponent automatically opposes all applications and would, by my standard, be an ideological opponent. Ideological opponents are not interested in trying to evaluate risk and benefit. If there is a risk, no matter how small, they are not willing to take it. I hope I have not stretched the definition of “ideological opponent” too far. I used it as convenient shorthand in a space-constrained format. In saying that biotechnology posed empirical, rather than ideological, questions, I meant that the outcome was amenable to evaluation. I gave examples of what I considered the empirical questions that must be addressed before deciding on the usefulness of Golden Rice. “Among them. Will poor Southeast Asians be able and willing to buy or grow Golden Rice? With what efficiency can malnourished children convert beta-carotene to vitamin A? Does Golden Rice have a significantly smaller yield than conventional rice?”

Empirical question also had to be answered by diabetics in need of insulin. There were risks involved for those who injected insulin isolated from animal sources. Nonetheless, almost all diabetics used it. Deciding to do so was the result of an implicit, if not explicit, decision that the benefits outweighed the risks. (As an aside, among the triumphs of biotechnology is the production of much purer insulin and hepatitis B vaccine from micro-organisms using the techniques of biotechnology.) Those opposed on ideological grounds would refuse treatment.

STARVATION IS A SOCIAL DISEASE, CAUSED MAINLY BY POVERTY, POOR FOOD DISTRIBUTION AND THE CONVERSION OF FARM LAND TO OTHER PURPOSES. I have believed this for a long time. Anyone with time on her or his hands and access to a law library, who is interested in my the subject, can find them in "The Environmental Movement: What Might It Be? (1975) Natural Resources Journal (The University of New Mexico School of Law) 15:327-351 or by request for a reprint.

THE PURSUIT OF TECHNOFIXES FOR HUNGER, EVEN BY WELL-INTENTIONED SCIENTISTS, AS KOHL PROPOSES, WILL LEAD US RIGHT BACK TO THE GOLDEN RICE AND STARLINK MESSSES WE HAVE NOW. THE PLIGHT OF THE PLANET’S 800 MILLION STARVING PEOPLE CAN’T BE ADDRESSED BY SCIENCE ABSENT THE REAL WORLD OF IDEOLOGY AND POLITICAL CONTEXT. DID WE LEARN NOTHING FROM THE MISTAKES OF THE GREEN
REVOLUTION? KOHL ACCUSES CRITICS OF "INDISCRIMINATELY REJECTING GMO TECHNOLOGIES," WHEN IN FACT THAT REJECTION IS FREQUENTLY CAREFUL, RESPONSIBLE AND SCIENCE-BASED.

A good example of an informative critique is “The Ecological Risks of Engineered Crops” by Jane Rissler and Margaret Mellon. Would that all of the discussion were so solidly based on data.

THE CEASELESS PROMOTION OF A SCIENCE THAT IS NOT READY FOR PRIMETIME DESERVES MORE, NOT LESS INDEPENDENT CRITICISM.

I agree that much of biotechnology is not “ready for primetime” in many of its applications. I argued in the original essay that “corporations most often operate with a bottom-line orientation in a lax regulatory environment” and that “(m)ost of the potential problems activists have highlighted are the result of racing to market.” I offered the opinion that among the results are the inattention to a number of problems, among them “the escape of transgenes from an engineered crop to wild relatives.” … “Had the goal been to bring the best, rather than the first, product to market, time would have been available to explore plausible strategies to respond to … potential risks. For example, genes spread in the environment when the pollen of genetically modified plants fertilize a plant of another cultivar of the same species or a wild relative. Although detailed protocols have not been worked out, current basic knowledge of plant reproduction should make it possible to eliminate” outcrossing from the genetically engineered plant to any other plant, even if it were of the same species. “New research is required to explore this possibility. Success in this endeavor would limit the spread of the transgene in the environment.” See Footnote #5 for issues of risk reduction.

WHILE DR. KOHL MIGHT WELL LONG FOR A PURE EXAMINATION OF THIS INFANT SCIENCE WITHOUT MESSY IDEOLOGICAL DEBATES, IT JUST CAN’T BE DONE.

I agree that ideological debate is essential. The most important issue to me, and I would guess to all of the letter writers, is the impact on the poor of the Third World. I am glad that Teite notes that it is an "infant science". It would be a shame to cut it off without ever exploring its potential to be useful in ways that we care about.

MARTIN TEITE               COUNCIL FOR RESPONSIBLE GENETICS

BILLY CHRISTISON, MISSOURI RURAL CRISIS CENTER, CHILlicothe, Mo.

DANNY KOHL ARGUES THAT JUDGMENTS ON BIOTECHNOLOGY SHOULD BE BASED ON FACTS RATHER THAN SUPPOSITION. AS A FAMILY FARMER, I COULDN’T AGREE MORE.

INDUSTRY RESEARCH COULD PROVIDE SIGNIFICANT INSIGHTS ON WHAT VALUE, IF ANY, GMOS POSSESS. IS INDUSTRY WILLING TO MAKE ITS RESEARCH AVAILABLE TO FARMERS AND CONSUMERS? NO. MUCH LIKE BIG TOBACCO IT SPENDS MILLIONS ON A PR CAMPAIGN TO CONVINCE CONSUMERS THAT BIOTECHNOLOGY HOLDS THE PROMISE OF ALLEVIATING WORLD STARVATION WHILE THEIR LOBBYISTS RESIST ALL EFFORTS TO INVOLVE THE GOVERNMENT IN RESEARCH, TESTING AND REGULATION OF GMOs. FOR FAMILY FARMERS THE PROMISE OF GMOs STANDS IN STARK CONTRAST TO THE REALITY. FOR THE LAST THREE DECADES US FARMERS HAVE BEEN REPEATEDLY TOLD THAT IF WE ARE TO SURVIVE WE MUST: PRODUCE FOR THE GLOBAL MARKETPLACE, REDUCE COSTS, AND BECOME MORE EFFICIENT. HOW DOES THIS PLAY OUT WITH RESPECT TO GMOs?

NUMEROUS COUNTRIES IN EUROPE AND ASIA HAVE BANNED THE USE OF GMOs BECAUSE OF CONSUMER CONCERNS, WHICH HAS EFFECTIVELY CLOSED MARKETS TO US FARMERS USING GMO SEEDS. IN FACT, MANY EUROPEAN AND ASIAN COUNTRIES HAVE BEGUN TO MARKET GMO-FREE PRODUCTS AND ARE PAYING FARMERS...
PREMIUMS FOR CROPS GROWN WITH CONVENTIONAL SEEDS. CROPS GROWN WITH
GMO SEEDS ARE FAR MORE EXPENSIVE TO PRODUCE. IN 1999 A FULL ROUNDUP
READY SOYBEAN SYSTEM—a GMO PRODUCT—COST FARMERS ABOUT 50 PERCENT MORE
THAN THE COST OF COMPARABLE CONVENTIONAL SEED AND WEED MANAGEMENT
SYSTEMS. DO GMOS PROVIDE MORE BANG FOR THE BUCK, MAKING THEM MORE
EFFICIENT? AGAIN THE ANSWER IS CLEARLY NO. A RECENT NEBRASKA STUDY FOUND
THAT GMO YIELDS WERE 11 PERCENT LOWER IN ROUNDUP READY SOYBEANS THAN
THEIR CONVENTIONAL SEED COUNTERPARTS AND CONCLUDED THAT GENETIC
ENGINEERING, NOT FARMING PRACTICES, WAS RESPONSIBLE. SIMILAR STUDIES HAVE
SHOWN 12 PERCENT AND 20 PERCENT YIELD REDUCTIONS IN GMO COTTON AND
CANOLA, RESPECTIVELY.

A FEW YEARS AGO WE WERE TOLD OF THE PROMISE OF BIOTECHNOLOGY AS PART OF
AN EXPENSIVE INDUSTRY SALES PITCH, BUT FOR THE FARMER, GMOS MEAN FEWER
MARKETS, HIGHER COSTS AND REDUCED PERFORMANCE. (FOR MORE INFORMATION ON
THE FARMER IMPACTS OF GMOS CALL TOLL-FREE (877) 968-FARM (3276).)

BILL CHRISTISON  MISSOURI RURAL CRISIS CENTER

If Christison’s experience is general, it is amazing that GM crops are so widely
planted in the US. Is it just that the seed companies are so persuasive that they
are able to convince farmers to act against their own best interest? Or is there
some other reason for their success in selling seeds? Might they make more
money selling the Brooklyn Bridge to unsuspecting farmers?

LETTER FROM JIM ROSE & SIGNE WALLER

DANNY KOHL HAS GOT THE POWER FLOW CHART BACKWARD—HE IS NOT DRIVING
MONSANTO; THE TAIL IS NOT WAGGING THE DOG.

I can’t imagine where Rose and Waller got the idea that I thought I was driving
Monsanto.

KOHL’S WOULD-BE OBJECT OF REFORM IS THE SAME DOG THAT BROUGHT THE BIOTECH
MARVEL INTO THE GENERAL FOOD SUPPLY IN 1996, WITH VIRTUALLY NO HUMAN
FEEDING TESTS, NO LONG-TERM ENVIRONMENTAL IMPACT STUDIES AND NO LABELING,
THEREBY MAKING GUINEA PIGS OF PEOPLE IN AN UNETHICAL EXPERIMENT WITH A
LOUSY DESIGN, SINCE THERE IS NO WAY TO TRACK EXPOSURE AND EFFECTS. Thus
CREATING FACTS ON THE GROUND, THE LIFE-AND-DEATH SCIENCES GOT US TO THE
POINT WHERE WE ARE TODAY: MORE THAN 60 PERCENT OF THE FOOD ON
SUPERMARKET SHELVES CONTAINS INGREDIENTS WITH GMOS AND, WHILE A MAJORITY
SAYS, IN POLL AFTER POLL, IT WANTS GMO PRODUCTS TO BE LABELED, MOST PEOPLE
ARE NOT EVEN AWARE OF THE FACT OF ITS UBiquitY. THIS FORCED FEEDING OF
CONSUMERS, AND THE PUBLIC IGNORANCE, WERE A CALCULATED STRATEGY OF
CORPORATE CONTROL OF THE GLOBAL FOOD SUPPLY.

WHAT THE CORPORATIONS TOLD US BY SNEAKING GENETICALLY ENGINEERED (GE)
FOOD IN LIKE A THIEF IN THE NIGHT IS NOT THAT WE DON’T KNOW WON’T HURT
US, BUT THAT IF IT HURTS US WE DON’T KNOW IT, OR CAN’T PROVE IT, AND ANYWAY
THEY WILL NOT BE LIABLE. KOHL’S ESSAY ILLUSTRATES HOW NARROW AND BLIND-
sighted THE OVERWHELMINGLY CORPORATE-SPONSORED SCIENCES HAVE BECOME.
SCIENTISTS ARE NO LONGER ASKING SEARCHING AND BASIC QUESTIONS, AND THEY
HARDLY LOOK FURTHER THAN THEIR OWN LITTLE KINGDOM OF SPECIALIZATION. DOES
KOHL GIVE ANY THOUGHT TO BIODIVERSITY AND THE BALANCE OF NATURE THAT HAVE
KEPT AGRICULTURE GOING FOR SOME TEN THOUSAND YEARS? HE SHARES THE HUBRIS
OF HIS CORPORATE MASTER MONSANTO,
Since this is the 4th such characterization of me as a Monsanto stooge, I should be used to it now.

That we can tamper with life at the basic level of the creation of novel species, and we can understand and control the consequences. What scientists today are getting corporate funding to keep track of the world’s biodiversity with a view to its preservation?

If corporations are supporting work on biodiversity, I am unaware if it. Fortunately there is a considerable effort by foundations and not-for-profit organizations like The Missouri Botanical Garden and The International Food Policy Research Institute. (Hundreds of papers on food policy research are available on this website.)

Studies by population and evolutionary biologists are supported by the National Science Foundation. The US Dept of Agriculture has initiated a new $1.8 million program entitled Biotechnology and Bio-diversity Interface. Details may be found on <http://www.usaid.gov/ftp_data/pub/OP/RFA/mop011084/>. There is little doubt in my mind that the USDA decision to initiate this program was a response to increased public concern about biodiversity. This is another example of how context determines what subjects are investigated.

The life-and-death sciences have absolutely no concern about biodiversity except to exploit little pieces of it and to turn them into commodities for profit. And what about human societies in the next year, or next ten years? What is the impact on poor farmers and on native and indigenous people? Maybe they want to preserve and grow natural and traditional varieties of crops, free from genetic pollution. Maybe they have too much reverence for nature to even fathom the arrogance of redesigning life.

Here is an example of what I consider to be ideological opposition. One cannot argue with deeply held values of those with whom you disagree. Maybe they just need land to grow food on so that they can feed themselves. But these political solutions “will not happen soon” thinks Kohl.

I would be happy to be convinced that it will happen soon. And so he recommends to us an interim techno-fix, just like all the other techno-fixes, the ones that destroyed much of the resource base of viable, communal agriculture. We have an organic vegetable farm and we sometimes use BT, a natural biopesticide. BT is now genetically engineered into many food plants so that they express toxin in every cell, all the time. (In its engineered form, BT does not quickly bio-degrade, as it does in natural form). Since there are BT crops in our farm area, we expect BT-tolerant insects to develop and render BT ineffective, thus making it more difficult to grow food organically.

For a few comments on BT, see Footnote #5. Corporations and scientists have predicted this outcome for years. Corporations figure they can sell more toxic pesticides and scientists count on working on the next techno-fix. Recently, Monsanto won a lawsuit against Percy Schmeiser, a Canadian farmer who had Monsanto’s GE canola growing in his field without having purchased Monsanto’s proprietary technology. Pollen drift from nearby GE fields ruined Schmeiser’s crop and his livelihood.

For a more complete accounting of the Schmeiser case, see Footnote #8. The international repercussions from this and similar outrages are just beginning.

Jim Rose & Signe Waller Earthcraft Farm,
LETTER FROM DAREL E. PAUL, MINNEAPOLIS

The fundamental point upon which the GMO debate pivots is the matter of public trust—trust of government, researchers and corporations that they will be cautious not reckless, generous not greedy, humble not arrogant. While there may be a scattered few geneticists throughout the world working toward knowledge and technology “free of costs and restrictions on property rights,” they will unfortunately always be in the overwhelming minority.

I suspect Paul is correct. But it seems possible that these few can do science in the public welfare. And the Golden Rice project has provided one model for how to be able to tackle orphan diseases and crops.

Moreover, the knowledge created even by well-intentioned geneticists can turn on its creators and those it is designed to benefit. And we cannot put the GMO genie back in the bottle once we have released him.

The uneasiness that Paul expresses so well is, I would guess, at the center of the resistance to GM foods. What is left out are the questions: (i) How important might the benefits be? and (ii) Can the risk be reduced to very low probabilities? Increasing the starch content of potatoes in order to make better French fries is worth no risk at all. However, controlling the plant viruses which can have a devastating impact on the productivity of subsistence crops, cassava and sweet potatoes for example, is quite another. This is a goal that merits the effort to make the introduction of virus resistant plants safe. And it should be possible to dramatically reduce the risk of transgene escape, although it would require some hard scientific work. (See Footnote #5) If the introduction of the virus resistant variety is done carelessly, there is a very real possibility of a seriously adverse outcome if (i) there are closely related weedy, wild species in the same region, and (ii) if the resistance were to routinely escape to a weedy, wild relative and (iii) if viral infection plays a large role in controlling the population of the weed. (This may be the case for virus resistant squash, see Footnote #9.)

The promise of GMO technology today reminds one of the promise of nuclear power half a century ago.

The hype does have the same ring as the “too cheap to meter” rhetoric after WWII. We need to look beyond the similarity to decide whether there are some products, under some circumstances that can make an important contribution to human welfare. And we have to insist on more stringent regulation than was applied in the squash case.

Better our efforts were devoted to fighting the underlying causes of poverty and malnutrition than supporting a dubious project more likely to end in disaster than bounty.

If it were a matter of “either/or”, I would make the same choice Paul does. But I see no reason to view it as “either/or”.

DAREL E. PAUL

LETTER FROM AMALIE CALLAHAN, ROCK ISLAND, ILL.

What subsistence farmers need is not genetically modified foods but organic gardening techniques and a variety of seeds from their own part of the world. Organic techniques build up a rich soil that increases production of crops. Also, poisonous insect- and weed-killers are avoided, as are artificial fertilizers, which harden the soil. A variety of crops assures that when weather or animals destroy one crop, others grow and yield food. Also, a variety is just what is needed for good health. Choosing
CROPS NATIVE TO THE AREA MEANS THEY ARE ALREADY ADAPTED TO THE WEATHER AND LOCAL INSECTS, AND THUS MORE LIKELY TO THRIVE. LET THE SCIENTISTS PLAY WITH THEIR OWN FOOD. FOR THE REST OF US, I SAY, “GET A SUBSCRIPTION TO ORGANIC GARDENING.” TEACH THESE TECHNIQUES TO THOSE WHO NEED THEM.

AMALIE CALLAHAN

I wish I were as confident of what is needed as Callahan is.

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  - 8. The Percy Schmeiser case.
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**Table 1: Prevalence (%) of Vitamin A Deficiency as judged by prevalence of Bitot’s Spot**

<table>
<thead>
<tr>
<th>State/UT</th>
<th>Bitot's Spot %</th>
<th>States with highest impact of Green Revolution</th>
<th>State/UT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandigarh</td>
<td>10</td>
<td></td>
<td>Kerala</td>
</tr>
<tr>
<td>Goa</td>
<td>10</td>
<td></td>
<td>Arunachal Pradesh</td>
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<tr>
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<td>10.01</td>
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<td>Nagaland</td>
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<td>Tripura</td>
<td>10.02</td>
<td></td>
<td>Dadra Nagar Haveli</td>
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<tr>
<td>Haryana</td>
<td>10.04</td>
<td>***</td>
<td>Assam</td>
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<tr>
<td>Delhi</td>
<td>10.05</td>
<td></td>
<td>Maharashtra</td>
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<tr>
<td>Haman &amp; Diu</td>
<td>10.05</td>
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<tr>
<td>Punjab</td>
<td>10.12</td>
<td>***</td>
<td>Andhra Pradesh</td>
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Bihar 10.14 Orissa
Manipur 10.14 Madhya Pradesh
Meghalaya 10.18 Mizoram
Sikkim 10.19 Tamil Nadu
Gujarat 10.2 Uttar Pradesh
Rajasthan 10.22 Pooled


Compiled by Shalini Kala, Skala@winrock.ernet.in

An alternative design would be to compare the prevalence of Bitot’s Spot before and after the onset of the Green Revolution.

1. Supplementation vs. fortification of food.

Vitamin A supplementation is not cheap. Using World Bank data (The World Bank. 1994. Enriching Lives: Overcoming Vitamin and Mineral Malnutrition in Developing Countries. Development in Practice Series. Table 2.1, page 15), Howarth Bouis of The International Food Policy Research Institute estimates the cost to be 50 cents per person per year (two doses per year including costs of administration.) Bouis estimates that South Asia might have 1.25 billion people at risk. If only 1 out of every 12.5 people (children and adult women) require supplements, that’s a cost of $50 million per year every year.

When a food is successfully fortified, it becomes a sustainable vehicle with low recurrent costs. The fixed costs are behind you and the varieties may be distributed throughout developing countries with benefits year in and year out. (Whether there will be benefits from golden rice remains to be seen.) The International Rice Research Institute in the Philippines is much further along with fortification of rice with iron produced by conventional breeding methods that it is with golden rice.

Perhaps the best example of successful fortification is the addition of iodine to salt. Like rice fortified with iron or beta-carotene, something of nutritional value is added to an item that is consumed anyway.

1. Alternative Voices from Africa

The Washington Post, September 11, 2000, Monday
SECTION: OP-ED; Pg. A23
HEADLINE: We’ll Feed Our People As We See Fit
BYLINE: Hassan Adamu. The writer is Nigeria’s minister of agricultural and rural development.
“It is possible to kill someone with kindness, literally. That could be the result of the well-meaning but extremely misguided attempts by European and North American groups that are advising Africans to be wary of agricultural biotechnology. They claim to have the environment and public health at the core of their opposition, but scientific evidence disproves their claims that enhanced crops are anything but safe. If we take their alarmist warnings to heart, millions of Africans will suffer and possibly die.

“Agricultural biotechnology, whereby seeds are enhanced to instill herbicide tolerance or provide resistance to insects and disease, holds great promise for Africa and other areas of the world where circumstances such as poverty and poor growing conditions make farming difficult. Fertilizer, herbicides, pesticides, machinery, fuel and other tools that richer nations take for granted as part of their farming regimen are luxuries in poorer countries.

“Moreover, the soil in tropical climates, or in areas with inhospitable weather, cannot be farmed successfully in the more traditional ways. These circumstances demand unique agricultural solutions, and many have been made available through the advances of biotechnology.

“To deny desperate, hungry people the means to control their futures by presuming to know what is best for them is not only paternalistic but morally wrong. Certainly, those with fertile lands and an abundance of food have every right to decide how they would like to grow their crops and process their foods. Organic farming, sophisticated methods of distributing food and other approaches are well and good for those who can afford to experiment. Starving people do not have this luxury. They want food and nourishment, not lectures, and we certainly won’t allow ourselves to be intimidated by eco-terrorists who destroy test crops and disrupt scientific meetings that strive to reveal the facts.

“It is wrong and dangerous for a privileged people to presume that they know what is best for everyone. And when this happens, it cannot come as a shock that those who are imposed upon often see this attitude as colonialist.

“Millions of Africans--far too many of them children--are suffering from malnutrition and hunger. Agricultural biotechnology offers a way to stop the suffering. As Florence Wambugu, one of Africa’s leading plant geneticists said recently, "In Africa, GM [genetically modified] food could almost literally weed out poverty."

“With regard to agricultural biotechnology, Africans are not asking for others to come in and grow our food. We are not asking for others to provide the financial means to establish this system in our countries. We want to come to the table as stakeholders. We know the conditions of our fields. We know the threats, the insects and diseases. We can work as partners to develop the seeds that could build peoples and nations.

“We do not want to be denied this technology because of a misguided notion that we don’t understand the dangers or the future consequences. We understand. We understand that this system must continue to undergo study and careful use. We also understand that agricultural biotechnology has been deemed safe and nutritious by a host of nationally and internationally respected organizations such as the National Research Council, Nuffield Council on Bioethics, World Health Organization, Food and Agriculture Organization of the United Nations, Organization for Economic Cooperation and Development, the American Medical Association and the American Dietetic Association.

“We will proceed carefully and thoughtfully, but we want to have the opportunity to save the lives of millions of people and change the course of history in many nations. That is our
right, and we should not be denied by those with a mistaken idea that they know best how
everyone should live or that they have the right to impose their values on us.

"The harsh reality is that, without the help of agricultural biotechnology, many will not
live."

THE END

As a second example of an alternative voice from Africa, here follows
an extended quote from an article in World Paper in December 1999.
The author is Dr Florence Muringi Wambugu, a well-known Kenyan plant
pathologist. Notice her emphasis on viral diseases of maize and sweet
potatoes, both subsistence crops. She might have added cassava to
the list. It is perhaps the most important source of calories in large
regions of Africa. Biotechnology may be the only viable approach to
producing resistant cultivars. While Monsanto had a hand in training
African scientists in the biotechnology that may result in resistant
cultivars, there is no conceivable way Monsanto can benefit from virus
resistant maize, sweet potatoes or cassava in Africa.

"Africa cannot feed its growing population, which is increasing at the rate of 3.5 percent
annually. Food production with traditional agricultural technology is growing by only 2.5
percent.

"The need for genetically engineered crops in Africa is, consequently, very great. Yet some
Western analysts claim the risks associated with genetically modified organisms (GMO's)
are too high, especially for Africa. They argue that major companies looking for new
markets here are likely to compromise on food safety and environmental issues in their
drive for profit. They also point out Africa's limited experience with biotechnology.

"What such people forget to consider is the obvious, clear and current risk of not using
GMO-based technology to increase food production in Africa's near future. But we must
not perpetuate with our inaction the mass starvation, hunger, malnutrition and death that we
have all borne witness to in Ethiopia and Somalia.

"Those of us familiar with the situation in Africa know that the concern about loss of
biodiversity is actually an argument in favor of GMO's. The use of this technology would
increase the production of crops per unit of land and thereby reduce current accelerating
losses of topsoil and biodiversity caused by farming in poor marginal lands and by
encroachment upon forestlands. These actions are desperate efforts to increase food
production and search for scarce firewood for cooking.

"Biotechnology is especially attractive for resource-poor African farmers, most of whom
cannot even read or write, because it is already packaged in the seed, making it user friendly
because farmers are not required to change their cultural practices or provide high-level
inputs to benefit.

"Farmers have had especially positive experiences with maize hybrid seeds of increased
quality and productivity. The average maize yield in Africa is 1.7 tonnes per hectare,
compared with the global average of 4 tonnes. The low yields are caused by diseases such
as maize streak virus, for which a biotechnology-based control project is in progress, and
insect pests, such as European corn borer, which transgenic Bt-gene biotechnologies have
been demonstrated to control....

"[A] success is the field evaluation and commercialization of the transgenic coat-protein-
gene-protected sweet potato, which is a food crop for the majority of subsistent small-scale,
resource-poor farmers in Africa. Introduction in Kenya is expected following the approval
by the Kenya National Biosafety Committee (NBC) in late 1999.

"Gene technology is considered the only viable long-term virus disease control approach for
application by farmers, and it has been developed by Kenyan scientists from the Kenya
Agricultural Research Institute (KARI) working at Monsanto company in the United States
from 1992 to 1998. Monsanto has promised to donate the technology free of royalty
payments for use in Kenya and Africa. There are no intrinsic food safety issues because the
coat-protein-gene technology has been regulated and then deregulated because of lack of
food safety concerns in the United States and elsewhere. It was one of the first
biotechnology applications approved for commercial use, and it could double yields in
Africa. Assuming, however, that the new protection might result in only a 15 percent average
increase in yield, then the total gain from the improved sweet potatoes would be 1.8 million
tons per year. With a subsistence growers value of about $275 per ton in Africa, virus-
tolerant sweet potatoes could potentially be worth an additional $495 million dollars a year
to African farmers. Moreover, the extra 1.8 million tons would supply half the dietary needs
of about 10 million people, with no additional production costs or inputs....

"An international biotech protocol that prevents transfer of technology will be to the
disadvantage of Africa. When the "imagined risks" of the North are put side by side with
the food needs in Africa, the risks associated with GMO's as new technologies become
quite a different matter. The rest of Africa is wanting, waiting and hoping that the
biotechnology revolution will not pass them by, as the Green Revolution did, due to a lack
of resources and unrealistic controversial arguments from the North based on imagined
risks."

3. Some of the problems in gaining the ability to get Golden Rice into the hands of
small farmers without cost.

From Plant Physiology (2001) 125(3): 1157

"Golden rice" was developed to prevent vitamin-A deficiency in the poor and disadvantaged
developing countries. To fulfill this goal it has to reach the subsistence farmers free of
charge and restrictions. Peter Beyer had written up a patent application, and Peter and I were
determined to make the technology freely available. Because only public funding was
involved, this was not considered too difficult. The Rockefeller Foundation had the same
concept and the Swiss Federal Institute of Technology (Zurich) supported it, but the
European Commission had a clause in its financial support to Peter Beyer, stating that
industrial partners of the "Carotene Plus" project, of which our rice project was a small part,
would have rights to project results. (The framework [IV and V] of European Union [EU]
funding forces public research into coalitions with industry and thus is responsible for two
very questionable consequences: Public research is oriented toward problems of interest to
industry, and public research is losing its independence.) We did not consider this to be too
big a problem because the EU funding was only a small contribution at the end of the
project, but we soon realized that the task of technology transfer to developing countries, the
international patent application, and the numerous IPRs and technical property rights
(TPRs) we had used in our experiments were too much for two private persons to handle
properly. We urgently needed a powerful partner (because of the deadline of the
international patent application). In discussions with industry the definitions of "subsistence
farmer" and "humanitarian use" were the most difficult problems to be solved. We wanted a
definition as generous as possible, because we not only wanted the technology to be free for
small-scale farmers, but we also wanted to contribute to poverty alleviation via local
commercial development. It is very fortunate that the company that agreed to the most
generous definition was also the company that had legal rights because of its involvement in
the EU project. This facilitated the agreement, via a small licensing company (Greenovation,
Freiburg, Germany), with Zeneca (Fernhurst, UK). Zeneca received an exclusive license for
commercial use and in return supports the humanitarian use via the inventors for developing
countries. The cutoff line between humanitarian and commercial use is $10,000 (income
from "golden rice"). This agreement also applies for all subsequent applications of this
technology to other crop plants. It turned out that our agreement with Zeneca and the
involvement of our partner in Zeneca, Adrian Dubock, were real assets in developing the
humanitarian aspect of the project. Adrian was very helpful in reducing the frightening
number of IPRs and TPRs. He also organized most of the free licenses for the relevant
IPRs and TPRs such that we are now in the position of granting "freedom to operate" to
those public research institutions in developing countries to proceed in introducing the trait
into local varieties. Publicity sometimes can be helpful: Only a few days after the cover
story about "golden rice" had appeared in Time, I had a phone call from Monsanto offering
free licenses for the company's IPR involved.

one paragraph omitted here

"Having overcome the scientific problems, and having achieved freedom to operate,
leaves technology transfer as the next hurdle. This is a far bigger task than anyone
having no personal experience should assume. "Golden rice" so far consists of a
series of provitamin-A-producing laboratory lines (TP 309). The characters of these
lines must be transferred to as many locally adapted varieties and ecotypes in as
many rice-growing countries as quickly as possible, and this transfer has to be
organized such that all rules and regulations concerning the handling and use of
GMOs will be strictly followed. Although we have had requests from many
institutions in many countries, we believed it would be unwise to start the technology
transfer on too large a scale. To aid in this endeavor, we have established a "Golden
Rice Humanitarian Board" to help make the right decisions and to provide
secretarial support. Again, our decision to work with Zeneca was extremely helpful.
Adrian Dubock was willing to care for the task of the secretary. We have additional
invaluable help from Katharina Jenny from the Indo-Swiss Collaboration in
Biotechnology (ETH Zurich), an institution jointly financed by the Indian
Department of Biotechnology (DBT; New Delhi, India) and the Swiss Development
Corporation (Bern, Switzerland). Golden rice will be introduced into India in the
established organizational framework of the Indo-Swiss Collaboration in
Biotechnology, which has 10 years of experience in technology transfer. Thanks to
this situation and thanks to the strong commitment of the DBT and the Indian
Council for Agricultural Research (New Delhi, India), India will take a leading role
and can serve as a model for other countries. The project will begin with a careful
assessment of needs, an analysis and comparisons of the pros and cons of
alternative measures, and setting a framework for the optimal and complementary
use of "golden rice." Of course, there will be bioavailability, substantial equivalence,
toxicology, and allergenicity assessments and we are grateful for offers from
specialists to help. Careful socioeconomic and environmental impact studies will
help to avoid any possible risk and make sure that the technology reaches the poor.
Care will be taken that the material is given only to institutions that ensure proper
handling according to rules and regulations. Traditional breeding will transfer the
trait into locally best adapted lines, and again will make sure that varieties important
to the poor will be used and not fashionable varieties for the urban middle class.
There will be also direct de novo transformation into important varieties, and this will
be done with Man selection (Lucca et al., 2000<http://www.plantphysiol.org/cgi/content/full/125/3/#B4> ). It is fortunate that
the World Bank, the Indian Council for Agricultural Research, and DBT will
probably share the costs for this development in India. Agreements have been
established with several institutions in Southeast Asia, China, Africa, and Latin
America and as soon as the written confirmation of the "freedom to operate" is in
the hands of the "Humanitarian Board," material will be transferred."

4. How might the public claim some of its share of the profit made possible by
public investment? In this case, there was some payback to the account of social
usefulness. As noted in Footnote #4, they did the hard work of obtaining waivers of the 70
intellectual property rights. The more serious problem is the way in which for-profit
comppanies depend on the basic research supported with public funds. Perhaps this is best
illustrated by recounting an incident at international meeting on the subject of biological
nitrogen fixation. The speaker at the large plenary session was the head of R & D at a
major life sciences company. During the question period following his presentation,
someone rose to ask if a particular finding resulting from a project supported with
government funds in an academic lab would soon be commercialized. The reply: "Oh, no.
That is still much too risky. More work must be done (presumably in an academic lab
supported by public funds) before we would be interested in it." I rose to say: "I don't
understand. I thought capitalism was a system under which, if you took risks and succeeded
you earned rewards. What you seem to be saying if that the public sector should take all of
the risks and the private sector reaps the rewards. Isn't the public sector entitled to a share of
the profits if it succeeds?" Suddenly, the session was over.

The public sector contribution to corporate success is much larger than the above story
suggests. Companies are free to pick and choose from published results, virtually all of
which are obtained in projects supported by public funds. After results are known, one can
pick through them and piece together an approach to a product that interests you. Most
often the company has to do more experiments to get what it wants. But it could not
possibly afford to recreate all of the information that is available to it at the starting line of
their project. I have no idea of the monetary value to companies of work done with funds
supplied by the taxpayers. But it clearly is substantial. Might it reasonable and feasible to
assess a surcharge on products whose development made use of the huge public database of
previous results. This money might go to a quasi-public agency, perhaps something
between a Rockefeller Foundation and the National Science Foundation which would be
charged with funding projects aimed at orphan crops and diseases - crops and diseases
which do not command the attention of corporations since there is no profit potential. The
mandate of such an agency might include bringing the products to market. If this is not a
good vehicle for recovering the public contribution to private profit, maybe someone else
can think of a better idea.

5. Risk reduction

A brief description of the biology of gene expression may be helpful for anyone not
familiar with the subject. Recall that all of the genetic information necessary to specify the
adult organism, whether it be a plant, a fruit fly or a human, is present when the sperm and
egg unite. Each cell in all organs of a given individual has exactly the same genetic
information. This information is packaged in genes that are a linear array of 4 nucleotides.
The difference between one molecule and another is the sequence of the nucleotides. The
information that specifies the sequence of the units (amino acids) that make up proteins is
called the coding sequence. All cells of a given organism have the same genes. Yet skin
cells and nerve cells make a very different suite of proteins. That is, some genes are
expressed in some tissues and not in others. The mechanism to accomplish this feat
Involves the role of **promoters**. The promoter of gene A is a sequence of DNA that comes before the coding sequence and serves as a landing pad for proteins which regulate the expression of the gene. The interaction of proteins that bind to the promoter specify when and in which tissue the gene will be expressed. In one example, the protein gene product of another structural gene (call it protein B) may bind to the promoter of gene A. When protein B is bound to the promoter, it prevents the coding sequence from taking the next step in the events that will lead to the expression of gene A; i.e., that results in the synthesis of protein A. In this hypothetical example, when the protein product of yet another gene, gene C, interacts with protein B, it removes it from the promoter and the promoter now “tells” the structural; gene to take the next step in making protein A (See diagram below.)

Gene A is not transcribed. Synthesis of protein A is blocked at first step.

Protein C interacts with protein B. Because of this, Protein B cannot bind to promoter. The first step in protein synthesis can now proceed.

To get a transgenic organism, a construct is made in which the transgene (a gene from another organism) you want to insert is upstream of a promoter of your choice. Since you most often want the organism to make a lot of the transgenic protein, you want to use a strong promoter. The “CaMV-35S” is a strong promoter with which molecular biologists have had a lot of experience. It is patented by Monsanto. Molecular biologists use it as a matter of convenience and because they know it will work.

With this as background, what are some of the problems with genetic engineering of foods. (a) **Expression of transgenes in all tissues**. Sometimes the target is in a specific organ. For example, if you want to kill weeds by disabling photosynthesis, there is no need for the transgene to be expressed in the edible seed. In principle, an organ specific promoter can be used which restricts expression of the transgene to a particular plant organ, such as the leaves. In the case of photosynthesis, a chloroplast specific promoter could be used since that organelle contains the photosynthetic machinery. One hears that work on such
promoters is going on in industry but is not being published, being kept, instead, as proprietary information. So it is not clear how much hard scientific work would have to be done to optimize conditions so that an organ specific promoter would be as easy to use as is CaMV-S35.

(b) Constitutive expression. In this case, the gene is expressed at all times during the life cycle of the cell. We all have experience with non-constitutive gene expression. For example, male infants do not grow beards. There are developmentally regulated genes in plants. In principle, one of these might be used to drive a transgene in an attempt to turn on the transgene during that part of the life cycle for which its expression is relevant. There are also wound-induced promoters. And finally, there are environmentally regulated promoters. As one example, there is a copper inducible promoter. When a dilute solution of copper sulfate is sprayed on the plant, the transgene is expressed. None of these promoters is as strong as is CaMV-S35 nor as easy to work with. Again it is not clear how far along is the work on new promoters nor how hard it will be to get promoters with the desired qualities. That sort of basic science is often done with public sector funds with the results being available to companies free of charge. I briefly discuss in Footnote #4 one way for the public sector to recover some of the reward for its investment.

c) Removing antibiotic resistance genes from the product. Molecular biologists often package the structural gene of interest within a piece of circular DNA called a plasmid. In addition to the promoter of choice, a gene for antibiotic resistance will often be included. The first step in the transformation (expressing the transgene in the organism of interest) often involves making a lot of DNA. To do this, they use protocols for getting the plasmid into a bacterium, usually Escherichia coli. The antibiotic marker gives them a way of know which bacterium the plasmid got into. The bacterial culture that was the object of the transformation attempt is spread onto a sterile solid surface of agar that contains all the nutrients the bacteria need for growth plus an antibiotic. In this case, only the bacteria that carry the plasmid will grow. As the bacteria divide, with the consequent increase in their number, the plasmid is also replicated and the researcher ends up with a lot of the promoter and the structural gene. But, unless steps are taken to eliminate it, the antibiotic gene is in all of the cells that contain the transgene of interest. (I am unaware of any evaluation of the potential for harm caused by this.) There are protocols in hand for eliminating the antibiotic gene. In fact, it was eliminated from Golden Rice. For a technical account see Ye, X et al. (2000) Science 287:303-305. For a more accessible description, see Ingo Potrykus (2001) Plant Physiology 125(3): 1157

d) Bt resistance. Bt is the shorthand for an insect toxin produced by the bacterium, Bacillus thuringiensis. It has a long history of use by organic growers. More recently, Monsanto has engineered the ability to synthesize Bt into a wide variety of crop plants. The most favorable outcome is that planting of seeds, such as Bollgard© cotton seed, can reduce the need for pesticide applications. There are places where pesticides toxic to humans are sprayed, often from crop dusting airplanes many, many times during the growing season. Worldwide this has resulted in the poisoning of large numbers of farm workers. An aside: For an account of this best-case scenario, see Monsanto’s account, available at <http://www.monsanto.com/monsanto/about_us/environmental_information> Click on 1999/2000 report, then click on "world development" in the left hand panel. Within this document, click on Hebei. Notice the issues that are discussed in their introduction. No one of us could have written better words. Monsanto’s motivation for entering into these cooperative arrangements is not stated. Is it to counter its bad reputation? (That would be fine with me if it resulted in a good project. It would be part of the fruit of environmentalists challenging their corporate behavior.) Or maybe they consider it
enlightened self-interest? (If they can prove that the of their product is beneficial, then they can sell seeds down the line.) The one Monsanto person involved in this effort whom I know is not only a very good scientist, but a good person. He says, as we all know, that Monsanto and other corporations "do not invest in developing products for non-profit applications. But we do share our technology & knowledge to help facilitate such work at public institutions and by non-profit foundations." (The effect of their efforts requires independent evaluation. In my opinion, they have earned skepticism.) Whatever their current motive for doing so, I feel certain that the spotlight under which their critics have placed them has contributed strongly to this effort.

I recognize that including this aside will only reinforce the opinion of some of the letter writers that Monsanto is my corporate master. Others will be reinforced in their opinion of my naïveté in being even willing to consider the possibility that something that Monsanto is doing will contribute to the welfare of small Third World farmers.

There is general agreement among ecologist that expressing Bt throughout the growing season, as the first generation of crops did is a recipe for the rapid emergence of resistance, an issue that has been of concern to organic farmers who use Bt. Fortunately, there is more than one Bt. I do not know whether the reports of the intention to include several versions in GM-pesticide plants have come to market. Nor do I know of studies that investigate the time course of the rise of resistance under these conditions.

(e) Transgene escape. The fear that a transgene might escape and become a superweed is, perhaps, the most widespread fear. This subject is thoroughly treated in the book "The Ecological Risks of Engineered Crops" by Jane Rissler and Margaret Mellon. Norman Ellstrand has written a readable, brief article with many references that let the reader follow the subject to great depth (Plant Physiology (2001) 125: 1543-1545.) There is no question that pollen of one species of plant can pollinate (fertilize) the female organ of wild relatives. The result, if the fertilization is successful, is a hybrid. Ellstrand concludes that spontaneous hybridization of crop plants with wild relatives appears to be the rule rather than the exception. Moreover, such "(H)ybridization with wild relatives has been implicated in the evolution of more aggressive weds for 7 of the world’s 13 most important crops. And such a hybrid sometimes possesses "hybrid vigor." The flip side of this problem is the extinction of the weedy species, the bearers of a significant fraction of the genetic diversity related to the crop plant. (This genetic diversity is important to plant breeders.) In the case of virus resistant squash (see Footnote #9), past experience would lead one to expect it to outcross to a close relative that is a weed of squash. Squash should become the poster child for demanding more rigorous regulation. The studies done were amazingly small. It is hard to see how the company got permission to distribute the virus resistant seed. Some biologists believe the gene flow between GM crop and wild population in rice poses an even larger potential problem. The weed (red rice) grows in the same field as the crop plant. Moreover, the crop plant and wild ancestor grow in close proximity in parts of Asia. The concern for the spread of the virus resistant trait in cassava in Africa is of much less concern since there are no wild relatives there. The case is very different in South America where cassava is an important food crop and there are about 50 species of the genus Manihot with which it can hybridize. The ecological cost of transgene escape is less important in some cases. For example, what if the RoundUp © resistant gene escaped from soybean and created a superweed? The worst result might be that RoundUp © would no longer be useful in growing that crop. Since RoundUp © is not used to control the weed in the environment, the resistance gene would be of no selective value to the weed. This is quite different from a scenario in which a weed becomes more resistant to high salt in soils.
Clearly the possibility (in many cases, the probability) of transgene spread and success in establishing stable populations is more serious in some cases than others. The spread of genes which create, say, salinity resistance from the crop plant (*Sorghum bicolor*) to the one of the world’s worst weeds, Johnson grass (*Sorghum halepense*) is a serious matter whether resistance is the result of traditional breeding or the use of genetic techniques. 

There are strategies for assessing and minimizing the possibility of transgene spread (see references above), but not everyone will find them convincing. A more radical remedy may be required if the potential for harm is to be avoided. 

Current basic knowledge of plant reproduction should make it possible to eliminate pollination by a genetically modified plant of any non-genetically modified plant, no matter how closely the two are related. New and difficult research is required to explore this or other possible approaches to make it difficult for transgenes to spread. The outcome need not be 100% effective, since the severe handicap in each generation placed on the spread of the transgene will make it impossible for plants bearing the transgene to become an important fraction of the population. Success in this endeavor would limit the spread of the transgene in the environment. 

6. Establishing priorities for the allocation of funds

Different funding agencies establish the areas of interest to them. So, for example the US National Institutes of Health allocates its multi-billion dollar budget to research done within the Institute, to research done outside of the Institute (mostly in academic labs), to specific disease categories (as AIDS, breast cancer, etc.) For details see <http://lrp.info.nih.gov/BioResearch/budget.htm>. You can imagine the amount of infighting that goes on in the process of making the allocation to each of its mission objectives. And you can bet that there is no category for support of home gardening in India. 

A rational allocation strategy would designate more funds for a project that you consider more important compared with one you consider of lesser importance. That does not mean that all funds should go into a single project or project type.

The real world problem of establishing priorities is seen in the following article from the NY Times.

**The New York Times**

June 24, 2001, Sunday, Late Edition - Final

SECTION: Section 4; Page 3; Column 1; Week in Review Desk

**In the Shadow of AIDS, a World of Other Problems**

BYLINE: By STEPHANIE FLANDERS

"SEVENTEEN million Africans dead and 25 million infected with H.I.V. have made their point. At this week's Special Session of the United Nations General Assembly, ministers and experts will agree that a multibillion dollar war on AIDS is global priority No. 1. They will say that, and they will mean it. But when talking about aid for the poorest countries, things are seldom that simple."

""AIDS is a catastrophe," said Dr. Lant Pritchett, a former economist at the World Bank who teaches development economics at Harvard. "And it's not fair, if treatments exist, not to give them to all these people who are dying. But it's also not fair that more than a third of children in Africa are malnourished. It's not fair that maybe 140 babies in every 1,000 will..."
die before the age of 1, and more than a third will never learn to read. All of it is unfair.

Unfairness is not the test for action."

"It is this kind of bleak calculation that gives economics a bad name, but that is what aid
choices are made of. Tugging at the sleeve of discussions about a $7 billion to $10 billion
global effort for AIDS is the worry that even here, tradeoffs apply. Although the new money
being pledged for AIDS is supposed to be in addition to current aid flows, many observers
fear that donors will simply divert cash from other lifesaving programs. Others worry that
funds in any amount will be misallocated on the ground. And even in the worst affected
countries, many wonder whether a dollar spent treating AIDS might be better spent
preventing its spread.

" Experts say that the greatest successes in eradicating a single disease -- the big example
is smallpox -- have come from single-issue campaigns to protect people against just that
disease. But the same experts also say that experience with malaria and tuberculosis shows
the risks of a narrow approach to AIDS.

"In the case of malaria, there was a cheap and effective treatment -- the drug chloroquine --
that was easy for doctors to hand out and for people to take. Making the drug more
available in developing countries in the 1960's and 1970's, in addition to extensive
prevention efforts, greatly reduced the human cost of the disease. Indeed, in a number of
countries, like Pakistan, it seemed all but defeated. But complacency and widespread
noncompliance (people taking the drug without finishing the course) led to drug-resistant
strains. Now malaria is back among the top three global killers.

"The story with TB, which has also grown dramatically in recent years, partly because of
the rise of AIDS, is more complex. But there too, drug resistance is a growing problem, in
part because patients are getting their TB treatments in places that do not have well-staffed
clinics and monitoring systems.

"According to one health economist at an international institution, who, like many, did not
want publicly to state views that seemed callous, these kinds of problems ought to give
pause to those congregating at the United Nations. "I'd rather we focused on all those other
things that we know how to fix," he said.

"There is no shortage of contenders. Immunization rates for measles have been falling
again, yet the disease kills nearly one million children a year in the developing world. Or
there is rotavirus, which causes severe diarrhea in 125 million children a year and kills
600,000 of them, the vast majority in the developing world. Or hepatitis B, which kills more
than a million adults every year because they did not get vaccinated when they were young.

"Michael Kremer, an economist at the Brookings Institution, has argued that heavy
investment in new vaccines for AIDS and other diseases is the only plausible long-term
solution. But studying the effects of a deworming project in schools in rural Kenya recently
reminded Mr. Kremer of all the nasty little diseases that rarely get a second's thought in the
developed world.

"AIDS grabs people emotionally in the West because they know people who have
AIDS," he said. "But in the developing world, literally hundreds of millions of children have
to live with things like schistosomiasis, even though the medicines to treat them have been
there for ages and are simple to administer."

"WORMS like hookworm and schistosomiasis infect 1.3 billion people a year, the vast
majority in very poor countries where children play in fields that double as latrines and
swim in infected streams and lakes. Less than 1 percent of these infections will lead to
death. But constant infection and re-infection can translate into years of discomfort and
stunted growth -- and prolonged periods out of school. Each worm can be easily treated
with one or two pills that cost about a $1.

"In fact, to combat diseases in the poorest countries, many would say that medicine may
not even be the right place to start. Dr. Philippe Maughan, who has worked for nearly 10
years as a doctor and aid coordinator in Africa and Asia, said: 'When I arrive in a new place,
my first reaction is always, I'm wasting my time doing health. I should be doing education.'
Mass education is the backbone of everything."

"When teaching rural health workers, Dr. Maughan always begins the first class by
writing the word "disease" on the blackboard and asking what the causes are. "The bright
ones pipe up with things like bacteria," he said, "but by the end of the session the
blackboard is chock-a-block: war, poverty, lack of schools, bad water, all of them feed into
disease. Focusing on any one thing is reasonably pointless."

"For Dr. Jody Heymann, policy director for the Harvard Center for Society and Health,
that is the argument for something comprehensive. "The call to action on AIDS needs to be
read as a call for more resources to go to Africa for what are truly global health priorities,
not a diversion of money from other humanitarian priorities," she said.

"Or, as the World Bank's president, James D. Wolfensohn, said recently, getting AIDS
treatments to victims in Africa is "Act V of a five-act play."

"To be sure, the moral arguments for treating people who are dying of AIDS are
compelling. They are also practical at a time when countries' very capacity to tackle disease
may depend on doctors and nurses who are themselves stricken with the disease. But the
bleak tradeoffs remain.

"If there's a fixed budget, it could be that many more lives would be saved by delivering
vaccinations for childhood diseases than by treating AIDS victims with antiretrovirals," Dr.
Kremer said. "Providing anti retroviral treatments in sub-Saharan Africa is estimated to cost
$1,100 per patient per year. It would be a real tragedy if that kind of money were diverted
from measles vaccinations, for example."

"Childhood vaccinations cost just a few cents and save an estimated three million lives a
year.

"If the poorest countries were less poor, or the industrial countries really opted to inject a
large dose of new funds, the choices might be less stark. For now, however, the giant
specter of one crisis -- AIDS -- may well be forcing the world to look away from myriad
others.

"Anyone who isn't worried about this isn't paying attention," said one official. "It is
anything but self-evident that it would avoid diverting energy and attention from broader
development efforts. All of history tells us that it would."

http://www.nytimes.com

GRAPHIC: Photo: A meeting at the United Nations this week is expected to discuss the
allocation of a new multibillion dollar fund to combat AIDS -- one of the world's leading
infectious killers. But will the new money simply be plucked from programs aimed at other
scourges, like the malaria that has stricken this child in Mozambique? (Agence France-
Presse)

Chart: "Human Cost of Infections"

Infectious diseases kill millions worldwide. Many could be cheaply prevented or treated.

Leading causes of death
Other: 6%
Respiratory and digestive disease: 9%
Complications at birth: 5%
Injuries: 11%
Cancers: 13%
Infectious diseases: 25%
Cardiovascular diseases: 31%

53.9 million deaths

Leading infectious diseases
Six diseases cause 90% of the total infectious disease deaths.

Measles
Malaria
TB
Diarrhoeal diseases
AIDS
Acute respiratory infections

Estimated Cost of Treatment or Prevention (selected diseases)

AIDS
$14 for a year's supply of condoms
TB
$20 for six months of medicine
Malaria

$10 for a bed net treated with insecticide
(Source: World Health Organization)

7. On Vitamin A requirements. It is not a matter of "all or none."
In his letter, Tokar writes: "Even if the beta carotene content could someday be increased fivefold, as Kohl suggests, it will still take 3 or 4 pounds of rice a day to satisfy a person's nutritional requirements, and that is only if other nutrients are in proper balance. There's much more beta carotene to be (had) in traditional crops, from leafy green vegetables to squashes, melons and mangoes." Michael Pollan, writing in the New York Times Magazine (3.4.01) put it this way: "...an 11 year old boy would have to eat 15 pounds of cooked golden rice a day - quite a bowlful - to satisfy his minimum daily requirement of vitamin A. Even if that were possible (or if scientists boosted beta-carotene levels), it probably wouldn't do a malnourished child much good, since the body can only convert beta-carotene into Vitamin A when fat and protein are present in the diet." While there are other parts of his article that I find equally disingenuous, the above suggests that it is worth discussing aspects of nutrition.
One can conclude that 15 pounds of cooked rice is necessary to meet the Recommended Dietary Allowance if one makes the following assumptions.

- 3 cups of cooked rice per cup of dry rice
- 1.6 micrograms beta-carotene per gram dry rice
- 1 unit of Vitamin A is converted per 12 units of beta-carotene

Recommended Dietary Allowance = 300 micrograms of Vitamin A per day

What is the "Recommended Dietary Allowance" (RDA)? For any nutrient, it is the intake at which the risk of inadequacy is 2-3%. The "Estimated Average Requirement" (EAR) is the intake at which there is a 50% risk of inadequacy. See the Figure below.

It is VERY important to note that the 300 micrograms Vit A per day is the RDA to maintain liver stores of Vitamin A. At this level, there is enough Vitamin A to ensure that it can fulfill all of its roles in metabolism. However, only 1/3 that amount, that is, about 100 micrograms per day, is the RDA to maintain retinal stores, the relevant parameter for good vision. In addition, Beyer (personal communication) reports that preliminary data support the possibility of increasing the content of beta-carotene in the edible portion of the rice by 3 to 5-fold.

Making these two changes in the calculation which lead to the conclusion that 15 lbs of cooked rice was necessary to meet the RDA for an 11 year old and using the value 200 grams of dry rice per cup, this hypothetical child would have to eat 0.35 to 0.6 cups of dry rice per day to satisfy the RDA for retinal stores. This is still a fair amount of rice. The weakest link in the assumptions used for this calculation is that 12 units of beta-carotene will be converted into 1 unit of Vitamin A. We have no idea whether this expected value for a well-fed individual is even close to what would be achieved under the anticipated circumstances. To use what must seem by now to be an overused phrase, this is an empirical question.

Whatever the bioavailability and the eventual contribution, if any, of golden rice to alleviate Vit A deficiency, the impact of Vit A intake on nutrition is not "all or none". Every little bit helps. This is illustrated in Figure 2 below.

Pollan quotes Gordon Conway of the Rockefeller Foundation: "We do not consider golden rice the solution to the Vitamin A deficiency problem." Pollan goes on wrote "So to what,
then, is (his emphasis) golden rice the solution? The answer seems plain: To the public-relations problem of the industry ... " It is reasonable to conclude that Pollan (as does Rossett - see his letter) thinks that either it must be THE solution or else it makes no contribution. I would bet a lot that neither of them applies this logic to many every day occurrences in their own lives.

Tokar, as well as Pollan, (as did I in the original essay) point out that children with little protein and fat in their diet may not convert beta-carotene to Vit A very efficiently. (Pollan is more assertive about the outcome than the above suggests. Why it seems appropriate to have a guess (hypothesis?) about the outcome of an experiment, deciding on the answer in advance is a more questionable methodology. (But that might simply be the difference in the constraints under which a journalist and a scientist works.) Their concerns about the bioavailability of beta-carotene in Golden rice did not spill over into their touting green and orange vegetables and fruits. (But I certainly agree with them that fruits and vegetables are a desirable part of the diet.) Whether the population at risk will be able to convert beta-carotene efficiently is one of several empirical questions that I posed in the original essay. As I wrote in a Letter to the Editor of the New York Times (which was not published) in response to Pollan's article: "To obtain valid data requires feeding trials. Field sized plots are required to harvest enough rice for the trials. Let the scientists do their work. I, for one, wish them godspeed."

8. The Percy Schmeiser case.

*St. Louis Post-Dispatch*

April 1, 2001, Sunday, FIVE STAR LIFT EDITION

SECTION: NEWS, Pg. A1

**HEADLINE:** MONSANTO'S WIN IN COURT SHARPENS BATTLE LINES IN BIOTECH FIGHT; FARMER SAYS PATENTED CROP FELL OR BLEW INTO HIS FIELD

**BYLINE:** Bill Lambrecht; Post-Dispatch Washington Bureau

**DATELINE:** WASHINGTON:

A court ruling favoring Monsanto Co. over a Canadian canola farmer is being heralded as an important victory for biotech companies trying to protect their patents on genetically modified crops.

But it is a victory that could carry a public-relations price: more concerns by farmers about big companies and the increasing use of genetically modified seeds. In a case being watched around the world, a federal judge in Saskatchewan on Thursday ordered farmer Percy Schmeiser to pay damages to Monsanto after the company's genetically modified canola was found growing in his field.

Val Giddings, vice president of the 950-member Biotechnology Industry Association in Washington, said that the case underscores the sanctity of patents in a relatively new industry.

"It's clearly an important ruling for the industry in North America with potential implications and ripple effects throughout the world," he said.

Schmeiser thinks the ripples will in the long run prompt farmers to be more leery of the impact of the new technology.
"Monsanto might have won this battle, but I don't think they've won the war," he said.

Schmeiser, 70, a former mayor and provincial legislator, argued that the Roundup Ready canola developed by St. Louis-based Monsanto had sprouted from seeds that fell from passing trucks or had blown onto his land from neighbors' fields.

Judge W. Andrew MacKay expressed doubts about Schmeiser's contentions but did not rule directly about the source of the seeds. Nonetheless, he said that Schmeiser should have known that the canola growing on his land was one of Monsanto's patented varieties.

Schmeiser was ordered to reimburse Monsanto up to $105,000, based on his profits from the 1998 crop. He also was assessed damages of $15,450, an amount equivalent to the technology fees he would have been required to pay for planting the herbicide-tolerant seeds.

The award was viewed as less important than the signals that the case sent.

**Ban on saving seeds**

In many parts of the world, farmers are bridling under the requirements of paying the technology fees to plant genetically modified seeds and prohibitions against saving seeds from their modified crops for future plantings. Seed-saving is a common practice throughout the world, particularly in developing countries.

In 1998, Monsanto suspected Schmeiser of illegally planting patented seeds and hired private detectives to collect samples that were sent to St. Louis for testing.

The patents on genetically engineered seeds are necessary for companies to recoup their investments on products, said Trish Jordan, a spokeswoman for Monsanto Canada. "We invest a significant amount of time and research into bringing new and innovative products into the marketplace," she said. "For us, this case was about patent protection. It was not about whether a gene transferred by pollen flow got a farmer hauled into court."

"Beyond their control"

Farmers in the United States and elsewhere are becoming increasingly worried about liability from wind-blown contamination from modified crops such as corn and canola. They have complained that the Agriculture Department has failed to consider liability from pollen while promoting biotech crops.

Leland Swenson, president of the 300,000-member National Farmers Union, based in Colorado, said that his organization had been awaiting the outcome of the Canadian case and was disturbed by the ruling.

"It says that farmers are going to be financially liable for acts of Mother Nature that are beyond their control," he said.

Swenson said that the court ruling suggests to him that farmers eventually will have to spend time determining what their neighbors are planting. "We have yet to face the ramifications of biotech's full usage and what it's going to bring about," he said.

Figures released Friday from the U.S. Department of Agriculture reflect the fears and hopes farmers have over the use of biotech crops. The agriculture department said genetically engineered corn seeds are expected to account for 24 percent of the corn crop this year, down from 25 percent last year. The dip follows revelations that a gene-altered variety of corn, known as StarLink, was found in the food supply without being cleared for human consumption.
But the use of biotech soybean and cotton seeds will climb, the agriculture department said. Sixty-three percent of the nation's soybean crop this year will be from genetically engineered seeds, up from 54 percent last year. And biotech cotton will account for 64 percent of this year's crop, up from 61 percent last year.

In Canada, where about 40 percent of 5 million acres of canola is genetically modified, Ernie Doerksen said that the Schmeiser ruling has generated a mixed reaction from farmers. "There's certainly a fair degree of sympathy for Mr. Schmeiser, but farmers realize that if he would have won, they might not have had access to Monsanto's new technologies," said Doerksen, general manager of the Canadian Canola Growers Association.

Schmeiser is a former mayor of Bruno, in Saskatchewan, and a fifth-generation farmer who has grown canola for nearly 50 years. During his battle with Monsanto, he has become well-known not just in Canada but around the world as a self-styled victim of the new technology. Since being sued, he has made speeches in 20 countries as far away as India and Bangladesh, often at the invitation of farm groups opposed to the shift to genetically modified crops. Schmeiser was supposed to travel to South Africa this month to begin another speech-making trip, but that journey is in doubt while he weighs an appeal, he said.

Schmeiser has another distinction that has contributed to his folk-hero status in some quarters: He's an adventurer who has climbed Mount Kilimanjaro and attempted Mount Everest three times, almost reaching its summit.

In an interview from his farm, Schmeiser spoke defiantly about the ruling but said he has not decided whether to appeal. He continued to insist that he did not knowingly plant the modified seeds that got him in trouble.

"It's a terrible position that this case is putting farmers into, just unreal," he said. "I guess it's just tough luck if you get Monsanto seeds on your land. What about the property rights of farmers? The judge didn't address that.

"The law isn't made for individuals and regular people. I don't see how any person, any farmer can stand up to a multinational company in court," he said, putting his costs so far in defending himself at $200,000.

Lori Fisher, a Monsanto spokeswoman, said her company would prefer to handle patent infringement cases without litigation. She said that Monsanto has about 22 similar suits pending in the United States.

"The reason we take these kind of steps is to protect our patents first and, more importantly, to make sure that there is a level playing field for all of the other growers that are respecting the patent laws and deriving benefits from the technology," she said.

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More information is available at

http://cbc.ca/cgi-bin/templates/view.cgi?/news/2001/03/29/monsanto_schmeiser010329

9. The story of virus resistant squash.
A SPECIAL REPORT: Few Federal Checks Exist on the Growing of Crops Whose Genes Are Altered

By CAROL KAESUK YOON

“For most of the 30 years Bernie Thiel has been growing squash, he has battled an invisible but potent adversary: viruses that can turn his neat rows of sunny-yellow vegetables into a mottled, sickly green harvest.

“Studies Note Risks of Genetically Modified Plants

Since genetically engineered crops came on the American agricultural scene in 1992, farmers have enthusiastically adopted these plants, last year harvesting genetically altered corn, soybeans and cotton from 50 million acres -- an area one and a half times the size of New York State. Meanwhile, several studies have been published pointing toward ecological risks from genetically modified plants.

“A major concern is that foreign genes from these plants could escape into wild plants by interbreeding. The fear is that wild plants endowed with new genes and potent new abilities, for example, to produce insecticide or withstand herbicide, might spread quickly, becoming difficult or costly to remove.

“Previously researchers talked about the movement of foreign genes into wild plants as unlikely, but the picture emerging today is that with many crops it will be inevitable. Recent studies of radishes, grain sorghum, canola and sunflowers found that genes, in one case foreign genes, moved quickly and easily from crops to wild relatives.

“Corn, soybeans and cotton pose no such risks in this country, as there are no plants with which they can interbreed. But other genetically engineered crops in development do have wild relatives in the United States with which they can interbreed including rice, beets, canola, sunflowers, cranberries and strawberries.

“There have also been a number of recent reports suggesting that the popular crops that produce the insecticidal toxin known as Bt may pose previously unsuspected risks. Bt corn, cotton and potatoes are already on the market but many more Bt crops are in development.

“Normally Bt is sprayed on plants to kill pests and is thought to remain active for a matter of days. But in sharp contrast to industry studies, Dr. Guenther Stotzky, soil microbiologist at New York University, has found that Bt toxin in the soil, as it might be found after a crop is plowed under, can remain active for at least eight months.

“We were surprised,” Dr. Stotzky said. "I'm sure it hangs around longer. We just terminated the experiment after eight months."

“In addition, recent studies of insect genes and insect development suggest that resistance to Bt may evolve more quickly than expected and that current resistance-management schemes for these plants may be ineffective.
“Other new studies suggest that Bt crops may have adverse effects on non-pest species. A study published earlier this year showed that, in the laboratory, monarch butterfly caterpillars can be killed by eating Bt corn pollen. Again in contrast to industry studies, Swiss researchers have published evidence that beneficial, predatory insects get sick when they eat Bt or eat pests that have eaten Bt corn.

“Ultimately, as with any new technology, risks must be weighed against benefits. So far researchers have found that some crops can provide striking financial and environmental benefits, but only under some conditions.

“The Department of Agriculture released a report in July showing that many farmers planting Bt cotton enjoy increased yields and decreased insecticide use, but many also do not.

“Proponents of the technology would like it to be all things to all people,” said Ralph Heimlich, deputy director for staff analysis at Economic Research Service, which put out the new study. Opponents prefer to claim it does nothing. The messy truth, however, lies somewhere in between.

“It really is a mixed bag,” Heimlich said.

“When you see a virus in your fields, it makes you sick,” said Thiel, showing a visitor a patch of ruined squash in his fields in Idalou, Tex., outside Lubbock. “There is no cure for it. You're done.”

“This year, however, Thiel fought back, trying out a yellow crookneck that genetic engineers had armed with resistance to two devastating viruses. In doing so, he joined hundreds of other American farmers embarking on what some scientists say is an uncontrolled ecological experiment carrying unknown risks: the planting of millions of acres of genetically engineered crops on American land.

“The United States Agriculture Department, the primary agency responsible for assuring the ecological safety of such plants, has not rejected a single application for a genetically engineered crop. Scientists who studied the approvals say the department has frequently relied on unsupported claims and shoddy studies by the seed companies. Department officials defend their decisions but acknowledge that their system for weighing applications is evolving.

“Since 1992, dozens of biotechnology crops have been approved for sale to American farmers and hundreds more are in the pipeline, with genes borrowed from every form of life: bacterial, viral, insect, even animal. Farmers like Thiel, seeking greater yields and profits, have enthusiastically adopted the new plants, using biotech seeds for 20 to 45 percent of the country's corn, soybean and cotton last year. Most Americans have probably eaten some food made with genetically modified soy or corn. But Thiel's squash, produced by Asgrow Vegetable Seeds, was the first approved bioengineered crop with the potential to spread its doctored genes into the larger environment.

“While fears that such crops are unsafe to eat have raised public alarm in Europe, and to a lesser extent in the United States, some biologists say the more immediate concern is this: that genetically modified plants could interact with the environment in hazardous ways, and that regulators are not demanding the proper studies to assess the risks.

“A close look at how the Asgrow squash made its way from laboratory to the dusty fields of West Texas, based on documents and interviews, shows that the virus-resistant strain was
approved without rigorous study, setting what critics say is a lax standard for assessing environmental risk.

“From the start, scientists were worried about the possibility that the squash could breed with wild squash, creating a "superweed" that would proliferate in the wild or farmers' fields, comparable to relentless invaders like the kudzu vine of the South and the zebra mussels of the Great Lakes.

“The critical question was whether viruses kept the population of wild squash, which produces inedible gourds, in check. Asgrow determined that they did not, by conducting a survey in which they did laboratory tests on 14 plants from 9 sites. None had the virus.

“Experts in environmental risk say the study proved nothing.

“‘What if we asked if the most important disease controlling human population sizes, malaria, was in fact an important disease?’ said Dr. Norman C. Ellstrand, an evolutionary biologist at the University of California at Riverside. "If you took 14 random individuals from around the world, the chances of picking one that has malaria would be relatively low, making the chance of getting a misleading result really high."

“Even scientists at Asgrow said that they could have done a more thorough job of providing information to the Agriculture Department on the plant's ecological safety.

“This was a learning process for all of us," said David Tricoli, managing research scientist at Seminis Seeds, which now owns Asgrow Vegetable Seeds. "I'm a molecular biologist. I'm not an ecologist." He said he believed the squash posed no risks.

“The Agriculture Department officials involved in approving the squash stand by their decision and note that there are no signs of environmental damage. But the department in effect acknowledged a lack of safety data this summer when another U.S.D.A. agency financed a study to determine whether the genetically engineered squash could create superweeds.

“We feel like we're making the best decisions that can be made on the basis of the information that we have,” said Keith Pitts, an adviser to the agriculture secretary. The agency announced Sept. 29 that the National Academy of Sciences would be conducting a review of the agency's regulatory process. Pitts added, "We don't claim to have this system totally worked out."

“A growing number of studies suggest that the genetically engineered crops could lead to rapid evolution of pesticide-resistant insects, creation of new plant diseases and harm to insects that benefit mankind. A recent laboratory study, for example, showed that corn pollen engineered to carry a toxin against the European corn borer can kill monarch butterflies.

“Eventually we are going to have some problems," said Dr. Allison A. Snow, a plant ecologist at Ohio State University. "I don't think the risks are being taken seriously or addressed seriously by the system we have now."

“Supporters of genetically engineered crops say such fears are overblown and are creating roadblocks for a technology that could feed the world and offer a host of other benefits. For example, Dr. Charles J. Arntzen, president and chief executive of the Boyce Thompson Institute for Plant Research, is developing bananas that grow medicines and could act as child-friendly vaccine delivery systems. Dr. Arntzen compared the risk posed
by genetically engineered crops with the risk of getting hit by an asteroid while sitting in his New York office: "The real risk is the hysteria."

“The Creation: A Plan to Build the Perfect Squash

For centuries, plant breeders have mated the plants bearing the biggest fruits to produce plants with even bigger fruit, and the hardiest plants to produce hardier ones. But emboldened by the biotechnology revolution, researchers envision giving the world crops that can do much more: fend off pests, thrive in hostile environments and bear fruit offering better nutrition and disease-fighting compounds. Soon, they say, genetically modified plants will serve as biofactories growing plastics and other products; one plant in development would grow cotton with polyester built right into it.

“One of the first companies to exploit the new technology was Asgrow Seed Company in Kalamazoo, Mich. In 1986 an Asgrow scientist, Dr. Hector Quemada, teamed up with Dr. Dennis Gonsalves, a biologist at Cornell University, to create a squash resistant to viruses, the bane of farmers. Four years later they were taking genes from two viruses devastating to squash and inserting them into the DNA of normal squash.

“The genes produce coat proteins, which encase a virus's genetic material. For reasons not fully understood, coat protein genes provide powerful resistance to the viruses from which they come. The result was the creation of a squash nearly invulnerable to the two diseases associated with those viruses.

“But before Asgrow could begin selling its new squash, it had to get the plant out from under Government supervision. Regulations for genetically modified crops required Asgrow to get federal permission each time the squash was planted in the field and to abide by a number of safety procedures.

“If deregulated, the squash could be freely sold or planted anywhere in the United States.

“So in 1992, Dr. Quemada and Tricoli petitioned the Agriculture Department, the main government body overseeing genetically modified plants, requesting that the squash be deregulated. (The Environmental Protection Agency regulates plants engineered to produce pesticides; the Food and Drug Administration does not require engineered products to go through an approval process, but is available for consultations.)

“In its petition, Asgrow, then part of the Upjohn Company, stated that the plant presented no risk to the environment.

“Industry officials and environmental groups watched the case closely. The squash was the second plant to be considered for deregulation, after the Flavr Savr tomato, and the first to raise the possibility of significant ecological threats.

“It was a test case,” said Dr. Margaret Mellon, director of the agriculture and biotechnology program at the Union of Concerned Scientists, a watchdog group. "We were all testing the waters."

“Scientists were concerned that the squash might turn its relatives into virus-resistant weeds by interbreeding with them. The squash also posed the risk that its virus genes or the coat proteins they produced might interact with other viruses to produce new diseases. And, as with any genetically engineered crop, the squash posed the risk that its new genes might cause it to spread and become difficult to control.
“Still, after two months the Agriculture Department issued a proposed ruling approving the squash. Environmental groups and some state agriculture departments protested, prompting the federal agency to commission a report by Dr. Hugh Wilson, a squash expert at Texas A University.

“But instead of backing up Asgrow and the Agriculture Department, Dr. Wilson agreed with critics. In his report in July 1993, Dr. Wilson found there was insufficient scientific information to draw conclusions about safety and that studies "point toward the clear presence of risk."

“Dr. Wilson's report revealed that Asgrow's petition contained crucial errors and omitted information that pointed toward risk. For example, Asgrow claimed that wild squash was unlikely to interbreed with genetically engineered squash, despite much scientific evidence to the contrary. Dr. Wilson's report also noted that the wild relatives of the new squash were already problematic weeds in parts of the country, suggesting it might take little to push them into the category of superweed, another fact omitted by Asgrow.

“Despite these findings, in the spring of 1994 the Agriculture Department again proposed approving the new squash and issued draft documents dismissing ecological risks.

“**The Superweed Threat: Assessing the Risk of a Gourd Gone Wild**

The most contentious of Agriculture Department's conclusions in the draft documents was the dismissal of the superweed risk.

“The department acknowledged that the new squash would interbreed with wild relatives and pass along its foreign genes. But the virus resistance could only create a superweed problem if viruses were preventing the spread of wild squash in nature. Asgrow had already shown that the wild plants were highly susceptible to viral disease in field experiments. In order to determine how important viruses were in nature, the department in 1993 asked Asgrow to conduct a survey of wild plants.

“Researchers did visual scans of an unknown number of plants in nine areas scattered over three states and saw no signs of disease. In addition, they collected 14 plants: one vine from each of eight areas surveyed, and six from a ninth area. Dr. Gonsalves tested the plants for viruses in the laboratory -- the only definitive way to test for viral infection -- and found no signs of disease.

“The survey, the Agriculture Department contended, proved that wild populations of the squash were not attacked by viruses. Therefore, the department concluded, the new genes would not be enough to turn wild relatives into superweeds. Therefore, the squash could be deregulated.

“But ecologists vigorously objected. They said it was impossible to draw such a conclusion from such a small number of plants over just one summer.

“**Dr. Peter Kareiva**, senior ecologist for cumulative risk assessment at the National Oceanic and Atmospheric Administration, called the study "amazingly small" and noted that if disease was truly a devastating problem, scientists might never find a plant with disease because the virus would have quickly wiped out any plants it encountered.
“Even Dr. Gonsalves, a co-creator of the squash, called the survey “preliminary data.” Dr. Gonsalves said the Agriculture Department’s decision “could be open for criticism. The sample is very small.”

But Dr. James White, senior operations manager with the Animal and Plant Health Inspection Service, the Agriculture Department agency that regulates genetically modified crops, defended the approval and the survey.

“There’s no evidence that the gourds were ever infected with the virus,” Dr. White said, “and there’s been no evidence since 1994.” He added that there were no known cases in any crop of a new gene resistant to viruses or other anything else making the crop or its wild relatives any weedier.

“Despite scathing criticisms of its conclusions, in December 1994, the Agriculture Department again dismissed ecological risks and gave final approval to the squash.

“In 1996, a second Asgrow squash with resistance to three viruses was approved by the Agriculture Department. A third Asgrow squash with resistance to all four major viruses is being tested in field experiments.

“Since then Dr. Quemada, in a surprising turn, has succeeded in persuading the Agriculture Department to support further analysis of the possible risks of the squash.

“After years of arguing on behalf of Asgrow that the squash posed no environmental risk, this summer, Dr. Quemada, now an independent regulatory consultant, received a $253,000 grant from the Agriculture Department to study whether the new squash posed a superweed risk and whether viruses infected wild populations.

“Dr. White declined to comment, saying he had not seen the grant. Dr. Quemada said he saw no conflict between his previous work and his receipt of the grant.

“The grant was paid for by the Biotechnology Risk Assessment Research Grants Program, a branch of the Agriculture Department independent of the Animal and Plant Health Inspection Service.

“The Regulators: A Safeguard, or a Rubber Stamp?

Ecologists say that more worrisome than any threat from the squash is the quality of science and the regulatory process that was used to deregulate the plant, a process meant to be the nation’s safeguard against ecological disaster.

“In a 1995 study of Agriculture Department petitions, Dr. Joy Bergelson, an ecological geneticist at the University of Chicago, and Dr. Colin B. Purrington, an evolutionary biologist at Swarthmore College, examined the seven petitions approved at that time and reported that much of the data was from critically flawed experiments. They also reported a "remarkable reliance" in the petitions on unsupported claims.

“Four years later, Dr. Bergelson said: "It still is the case. A lot of the key experiments don’t seem to be being done."

“Part of the problem, scientists say, is that the Agriculture Department has set no scientific standards for proving the environmental safety of a plant. Government agencies regulating new products often demand specific experiments and data to establish safety. In
contrast, the Agriculture Department asks only that petitioners explain why the new plant is unlikely or likely to pose a number of broadly defined risks.

“Most of the tests that companies do use to argue for a crop’s safety, researchers say, are inadequate for risk assessment because they are designed specifically to avoid ecological risk. For example, in field trials flowers are often covered to avoid interbreeding with wild plants. In addition, field tests typically run for one or two years, too short a time, ecologists say, to assess a plant’s potential weedyess.

“Dr. Arnold Foudin, assistant director of scientific services at the Animal and Plant Health Inspection Service, defended the regulatory process. The requirements are not vague, he said, but rather are "necessarily generic -- it gives us the flexibility, and the applicant, to supply the necessary information." He added that he believed longer field tests were impractical.

“Many scientists, particularly those who genetically engineer plants, applauded the approval of the squash and said environmental risks were overblown. Supporters of genetically engineered plants say critics ask the impossible: technology without risks and a promise of unconditional safety.

“In an ideal world you'd know all the risks and all the benefits before you use something,” said Dr. Herb S. Aldwinckle, plant pathologist at Cornell University, "but we'd be very slow to progress if we had to know all that.”

“Ultimately, risks posed by these crops must be weighed against the benefits they offer farmers, consumers and the environment. But even as the first large-scale studies of benefits of genetically modified plants appear, more questions than answers remain. Even for Asgrow's squash, the plant that Tricoli called "the most highly regulated and reviewed squash product ever produced," the costs and benefits to farmers and the environment remain unclear.

“In Idalou, Thiel, who has been planting and picking squash all his life, was philosophical. "We've got a long way to go before we know whether it's good or bad," he said. "The way I see it, whenever you get something, you lose something else. We just don't know what we'll lose yet.”