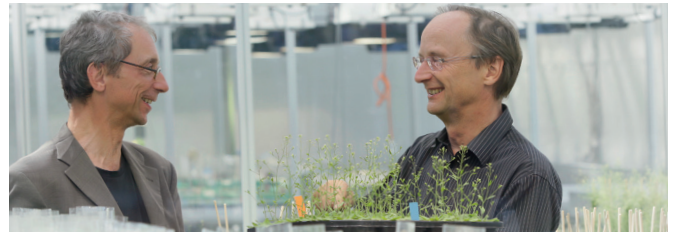


Green gene technology

Experimenting on nature – a debate

Moderator: Martin Thureau



Source: Jan Greune / LMU Munich

The role of gene technology in agriculture is the subject of passionate debate. In a Research Focus organized by LMU's Center for Advanced Studies, experts in various disciplines sought common ground. In insightLMU, plant biologist Jürgen Soll and sociologist Bernhard Gill revisit their positions.

Some 12% of agricultural land worldwide now bears genetically modified crops. What is the figure in Germany?

Soll: No transgenic crops are currently being cultivated in Germany, not even in field experiments as far as I know. This situation is unlikely to change soon, and one of the largest German agrobiotech firms, BASF, recently moved its research division to the US. However, the volume of imports derived from genetically modified (GM) plants is quite considerable. Germany imports about 75 kg of transgenic soybeans per person per year, mostly for use as animal fodder. But, as I say, not much is grown anywhere in Europe.

Why is that?

Soll: First of all, because society has yet to reach a consensus on the utility and potential of GM crops. We in Germany live in an environment in which enough food can be produced by conventional methods. It is hard to convince the consumer of the advantages that transgenic strains offer.

Let's take a well-known example, the so-called *Bt maize* developed by the American concern Monsanto. One variant carries a bacterial gene for a toxin to which the European corn borer, a grain pest, is susceptible. This maize strain has been approved by the EU, but some

member states, including Germany, do not allow it to be cultivated. Why?

Soll: That is something I do not understand. The same toxin is sprayed on large areas of strictly controlled, Demeter-certified, organically farmed land. It is harmless to humans and other animals.

Gill: But the pest gradually becomes resistant to it.

Soll: Resistance will ultimately arise no matter what agent or mode of application one chooses. It is true that glaring errors in resistance management have been made in the US, but that does not invalidate the principle.

Monsanto – not exactly famous for reticence or restraint in matters of business – itself advises caution here. The company now recommends that 50%, not 20% as before, of the cultivated area should be given over to so-called refuges, plots planted with conventional maize that cannot produce the toxin, to reduce the selection pressure on the pest and slow the spread of resistance. One doesn't have to be a diehard ideologist to conclude that *Bt maize* is not the big breakthrough in pest management.

Soll: As I just said, there is always competition between the plant-protecting effect of a pesticide and the evolution of resistance.

Gill: However, the expansion of *Bt maize* cultivation to vast areas of cropland will rob the organic farmer of a useful weapon, as the increased selection pressure will ensure that all problem insects eventually become resistant to the toxin.

Soll: If acquired resistance does spread, this could indeed pose a problem for organic farming in the US.

Is the German ban on the planting of *Bt maize* based on plausible estimates of risk or is it a roundabout way of preventing the cultivation of transgenics altogether?

Soll: The German Research Foundation (DFG) and the Federal Ministry for Education and Research have invested large amounts of money in risk assessment. None of their studies has found evidence that transgenics are a threat to the environment or to human health.

Are all the arguments in favor of the ban then invalid?

Soll: Cultivation of *Bt maize* is associated with a rise in biological diversity relative to conventional maize fields. The corn borer and some related species suffer, but the plant otherwise promotes diversity and sustainability by reducing the amount of insecticide the farmer needs to apply. The counterarguments are all motivated by the fear of losing votes.

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Gill: We have seen Bavarian Prime Minister Horst Seehofer suddenly reverse his stance on the issue. At first, he was all in favor of transgenics, but then his pollsters whispered in his ear that his party, the CSU, might lose electoral support as a result. The more fundamental problem, however, is that EU law leaves no room for a politically motivated ban on the cultivation of *Bt maize*. So member states bend over backwards to argue that there are risks, although bans are actually inspired by other concerns, touching on the future of rural landscapes, the fate of agricultural traditions and on agricultural policy in the widest sense.

Do you think consumers would be less opposed to gene technology in agriculture if they knew more about it, as many people like to argue?

Soll: Studies have shown that factual knowledge is not what determines whether one is for or against. In places like the Ammersee region, where I live, rejection is popular, but the level of education is above average. So it's not just a matter of how much a person knows.

Gill: These studies show that people have a particular mindset, which affects how they react to the information on offer, how they filter and interpret it. This makes them more likely to accept some arguments and to reject others. Information campaigns alone do not alter their basic attitudes.

Soll: On the other hand, the public did begin to take a more favorable view of so-called "red gene technology," i.e. its application in medicine, when doctors were able to offer compelling reasons for its adoption. Why should diabetics use pig insulin when biotechnologically produced human insulin is available? The perceived benefits decided the argument. We are now in a similar position.



"Biotechnology must become more biological, i.e. more complex," says Professor Bernhard Gill.

Which means more to the consumer? The price, or the nutritional quality?

Gill: Medicine was understood to involve direct intervention in natural processes long before the advent of gene technology. With food, we have the paradoxical situation that, for the past century, the food industry, which in effect "denatures" foodstuffs, has advertised its products as "natural." So the consumer's insistence on "naturalness" has a long tradition. In the US, this obviously plays less of a role, and in Northern Europe, the Netherlands especially, the idea of naturalness is not as important as in Southern Europe or German-speaking countries. The Protestant-Catholic divide may have something to do with that. Then in Germany there is a further split. In the South, where farms tend to be smaller, opposition to gene technology

is far more widespread than in the North and East.

If the utility of the products on the market was more obvious to the average consumer than in the case of *Bt maize* or "gene soya," would that increase their level of acceptance?

Soll: Perhaps. Consider sustainability. Modern agriculture as it is practiced today is not very environmentally benign. Potatoes, for instance, are often sprayed with fungicides to prevent blight, and organic farmers use copper salts containing heavy metals. In this sector gene technology can help the environment, and that might send a more positive message to consumers. We now have transgenic blight-resistant potato varieties. Transgenics of the first generation were herbicide-resistant but, in most cases, did not reduce herbicide use. The second generation focused on pest resistance, and some of these have had very positive social effects in certain regions of the Third World. The next generation could promote sustainable farming in the developed world.

Gill: But to do this, biotechnology must extricate itself from the embrace of the agro-industrial complex and pesticide makers. So far, all agricultural biotechnology has come from the chemical industry; in a sense, it has simply been an extension of chemical agriculture. Biotechnology must become more biological, i.e. more complex. Instead of enabling plants to make substances invented by other organisms, we must modify the plant's own metabolism to suit local conditions. I can't imagine that the chemical industry, which has done most to commercialize biotechnology, has any interest in such an approach.

Soll: But one can't keep industrial firms out. Markets for staples like maize, rice, cereals, oilseed, are so big that they will always attract strong economic interests.



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Large concerns have less incentive to invest in crops like our local fruits; the scale is too small. A Swiss colleague of mine has used gene technology to generate scab-resistant apples. He isolated the resistance gene from an ancient apple stock that can no longer be crossed with modern varieties. He then used normal breeding methods to eliminate all genetic material derived from organisms other than apple. The result is a so-called cisgenic strain, one that has been modified by genetic transformation but retains no foreign DNA. Clearly, this can contribute to sustainability – particularly when one considers how apples are now grown, on the shores of Lake Constance for instance. For decades, the trees have been exposed to broad-spectrum antibiotics like streptomycin, which are applied in large weekly doses by spraying. Huge amounts leach into the soil, where they induce resistance. Yet debates on green gene technology focus

on the far lower risk that soil bacteria might pick up resistances from transgenic plants.

As part of a large research network, you are now studying the basis for stress and drought tolerance in plants.

Soll: We use thale cress (*Arabidopsis*), an indigenous weed that is widely used as an experimental model in plant biology. Under stress, plants activate emergency response programs, as everyone who has a garden will have noticed. During a drought, they flower sooner, yields go down, and germination and tillering are poor. Improving drought tolerance in crop plants would help stabilize year-on-year yields.

How long will it take to get such plants into the field?

Soll: About 10 to 15 years, regardless of whether one uses transgenic or classical breeding methods.

The front lines in the debate on gene technology in agriculture have not shifted much over the last 20 to 25 years. Its promise is perhaps less loudly proclaimed and warnings about its risks may have become less strident.

Soll: The initial visions were certainly overoptimistic. And applications of the technology in agriculture are always equated with agribusiness, as if gene technology had led to monocultures. There may be grounds for unease about intensive agriculture, but monocultures have long been with us, and one can't make green gene technology responsible for them.

Gill: To some extent, one can. Gene technology is expensive. As Professor Soll pointed out, the big commercial players concentrate on things that are likely to produce substantial profits – and that furthers the trend toward monocultures, and restricts the number of cultivars used. From this point of view, gene technology is not an entirely neutral tool. One should also remember that public funding for plant breeding research has dried up during recent decades, which partly accounts for its increased commercialization. In addition, developments in patent law have made it possible to patent individual genes, leading to consolidation in the seeds business and the dominance of the chemical industry in this sector.

Soll: To ensure that a few commercial enterprises do not monopolize the technology, Germany needs to invest more public money in plant research. Biomedical sciences receive far more government funding than plant sciences.

Do you think more money will be forthcoming?

Soll: Difficult to say. At the moment, the food vs. fuels debate is back in vogue. Quite frankly, bioethanol is a pretty stupid idea. From an ecological point



„One has to consider the repercussions, the impact on sustainability and the ecological balance sheet, at the outset,” argues Professor Jürgen Soll. „Maybe then, strategies that make sensible use of gene technology would be more welcome.”

Source: Jan Greune / LMU



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of view, it would be better simply to incinerate the wheat. But, 15 or 20 years ago, politicians all over Europe decided to subsidize it, and it's not easy to reverse that decision. Every consumer can see the results. Fields of maize are everywhere, even in Bavaria. When I came here in the 1980s, no rapeseed was sown anywhere in the state. But it too has become ubiquitous, thanks to biodiesel. My point is that one has to consider the repercussions, the impact on sustainability and the ecological balance sheet, at the outset. Maybe then, strategies that make sensible use of gene technology would be more welcome.

The very title of this Research Focus at the Center for Advanced Studies locates agriculture and green gene technology "between 'idyll' and 'dystopia'". Perhaps you could comment on these polar opposites.

Soll: The quest for the idyllic is never-ending. The consumer perceives nature with the eyes of the rambler, who goes on a hike in the open air every weekend, with his children and his dog. He looks on nature and thinks he understands it, yet he has no idea what is in the food he eats every day. He has lost any real relationship with the natural environment. What's left is this vague emotional bond. This is modern man's dilemma.

Gill: I see this romantic or traditional attitude to nature in a more positive light. It might seem rather ridiculous to a natural scientist but, as a sociologist, I see it more in terms of the important function it has in the symbolic order that holds a society together. Before the emergence of the natural sciences in their modern form, it was possible to reconcile the practical exploitation of nature with its moral and aesthetic connotations, to form an integrated world view. Even for people who would

not describe themselves as religious in a conventional sense, nature still has a significance of its own, as a focus of yearning, as a source of identity. That is why symbols drawn from nature remain so central for us. In this context, there is no point in establishing a new nature reserve encompassing thousands of hectares in a remote corner of the country. People want to identify with nature as they experience it in their everyday surroundings and routines, and particularly with nature as they encounter it in the food they eat.

Soll: But there are no genuinely natural settings anymore, all our landscapes have been formed by human endeavor. Even the nature reserve *Bayerischer Wald* is far removed from its pristine state. I grew up on a farm. I lived through the decline of small farms that was already underway in Northern Germany 30 years before it began in Bavaria. I remember how people were forced out of agricultural production and had to seek other jobs. Very few people in rural areas today actually work on the land. That is why the population as a whole has lost touch with agricultural production.

Gill: But creating a haven of organic production for a small economic elite like the one around the Ammersee, with food that is far more expensive than anywhere else, is not the point. A niche like that makes no ecological sense, because the areas under cultivation are far too small. Instead, one should try to make agriculture everywhere more ecologically adaptable, and reduce its reliance on synthetic chemicals. Achieving this goal on the more highly industrialized farms in Northern Germany requires a different approach to the one most appropriate for the South, or in Southern or Eastern Europe. It would be a great help if the EU were to replace its yield-based subsidies by a system that promotes a multifunctional form of

agriculture – in other words, would take practical steps to implement the policies it so often preaches. But the lobbyists who work for large industrialized producers have so far managed to block all attempts to realize this.

What have the two of you learned from this collaborative enterprise?

Gill: Natural scientists, social scientists and specialists from the humanities all worked together on the project, something that doesn't happen very often.

Soll: Practically never! At any rate, we biologists now have a better understanding of the factors and interdependencies that shape the debate. How do we get an impartial, open-minded debate?

Gill: I was agreeably surprised by the fact that, for once, the laboratory scientists did not see the issue solely in terms of a lack of the relevant knowledge. I also learned lots of little things that were new to me, for example that there is a big difference between the simple logic behind the kind of mass-screening approach that a concern like Monsanto employs during the development of a new compound and the complex strategy that the groups in the Bavarian research network Forplanta use to probe metabolic pathways. For me the question now is how the diversity of viewpoints that emerged from the interactions at CAS can be utilized to develop a sustainable approach to agriculture. For instance, in the EU there is an ongoing debate on whether member states should be allowed to opt out of implementing green gene technology. To my mind, the individual member state is not the most appropriate level on which to apply such a policy, because its agricultural structure is too heterogeneous. I would ask why one should not allow smaller administrative regions, such as counties (*Landkreise*), to decide by plebiscite whether they want to employ



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biotechnological methods in agriculture.

Soll: I find that a frightening prospect. The true potential of plant gene technology is barely discernible, and individual counties preemptively reject it in the name of “God’s creation” and declare themselves “gene-free”. When Markus Söder was Minister for the Environment in Bavaria, he sometimes appeared personally to present the badges. I would regard as extremely dangerous any attempt to allow such far-reaching decisions to be taken at a local level. We have to come up with a regulatory framework that enables us to manage a mixture of both farming models. How much fragmentation that entails will depend partly on how big the zones between fields must be to minimize the dispersal of GM pollen.

Gill: It might be a good thing for green biotech if some counties, in Mecklenburg-

Vorpommern or anywhere else, were actually to vote in its favor. It is not inconceivable that a majority might vote for cultivation of GM crops.

Soll: Such a course as you suggest would only reproduce on community level the polarization we now have at the Federal level. This will not make the discussion itself any more fruitful.

Gill: Otherwise, you will have debates between neighboring farms.

Soll: There is no evidence that the technology poses any health risk to consumers. Does that give the consumer has a right to transgene-free food?

Gill: In a liberal market economy the consumer certainly has that right, provided she is willing to pay for it.

Soll: Where then does one draw the line? What is transgene-free? Is it to be a matter of zero tolerance? From a technical standpoint, that may well be

unrealistic even now.

Gill: Just so I understand you correctly, why do you object to the debate itself? At present we have differentiation on a large-scale, coexistence at the continental level, so to speak. In the US, transgenic food is being grown, but not in Europe or Japan. So the argument pro and contra is already with us. And a democratic decision, at county level if necessary, need not be irrevocable; it could be changed if the latest products on the market really are better.

Soll: Rejection of transgenics would at all events infringe the rights of the farmers on the losing side, even if only temporarily. But the whole scenario is hypothetical in any case, because, for political reasons, there is no hope that GM plants will be sown on cropland anywhere in Germany in the coming decade.

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Prof. Dr. Jürgen Soll

is Professor of Plant Biochemistry and Physiology at LMU. Born in 1953, he studied Biochemistry at Hannover University and obtained his PhD there. He then did a postdoc at the University of California in Berkeley, and completed his *Habilitation* at LMU in 1986. He later held professorships at the University of Saarbrücken and the University of Kiel, before returning to LMU as Department Head in 2001. Together with Nikolaus Pfanner, Jürgen Soll was awarded a Leibniz Prize by the German Research Foundation (DFG) in 2001.

