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The Weed

The first plant has been decoded. The agricultural revolution has now begun.

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Arabidopsis thaliana is a modest weed, a highly adaptable and ubiquitous companion of cultivation found in waste places. This skinny little plant, also known as mouse-eared cress, has indeed come far. It thrives on every continent and is so well adapted that it shoots its ripe seeds up several meters from its stem – a survival strategy that defies even intensive weed control efforts. But this long, thin plant, barely 20 centimetres tall, has also achieved success in an entirely different realm. An easy-to-cultivate, extraordinarily fast-growing species, it has become an object of genetic research in a class of its own. Volumes could be filled with the scientific publications devoted to it. Ideally suited to the achievement of solid scientific results in the shortest possible time, it is truly a researcher's joy.

This delicate little plant is so popular that it has now been honoured as the first higher plant to have all of its genes mapped. The gateway to the genomic age in botany is about to be opened with the presentation of the plant's genomic map by the members of the Arabidopsis Genome Initiative in Tokyo, Washington, London and Brussels. Science and agriculture around the world can be expected to benefit enormously. In his article in the July 16, 1999 issue of *Science*, Somerville was right on target in predicting that the sequencing of this genome would be completed by the end of the year 2000.

This breakthrough, which will have a much more profound impact on food production than the "Green Revolution" of several decades ago, could enable us at long last to achieve rapid progress in the breeding of the most common crop plants such as rice, corn and wheat. The growth of genetic knowledge will have consequences one never could have imagined before. The most promising genes of crop plants will be an open book within only a few years from now. Significant progress has already been made with the genetic material of the rice plant, and major private agricultural corporations have made some of the fruits of their rapidly intensified research available – free of charge – on a world-wide scale.

One must try to imagine what this can mean for the future of crop plant development. From now on, researchers will no longer be dependent on trial and error. They will know precisely what is really happening each time varieties are cross-bred – for cross-breeding is still the basis of every breeding operation. With the aid of species-specific marker genes, it has now become possible in the case of very large and complex genetic codes (such as that of wheat) to determine precisely what has actually taken place during gene recombination in a successful cross-breeding operation. This will help accelerate the development of new varieties tremendously.

We learned extraordinarily quickly from the early years of genetic engineering through experiments involving the introduction of individual genes from other organisms into genetic material. Some of these first-generation transgenic plants have since been introduced in many different countries and are now producing good yields. Although the ecological and economic benefits vary from region to region, and have been only modest in some areas, farmers who have been able to use these varieties effectively are thoroughly convinced of the advantages they offer.

The rapid expansion of genomic knowledge will soon make it possible to create resistances against parasitic fungi that are still causing disastrous crop damage today. We should be wary, however, of simply replacing the chemical "club" with the genetic club in the field of pest control. We would be far better off applying the elegance of breeding methodology to more meaningful goals.

Efforts to realise romantic notions about nature in the fields with the aid of genetic technology surely make little sense today. It should be possible, however, to increase species diversity in the agricultural context and thus put an end to the dismal reign of monocultures. Our endless war against wave after wave of new pests on these vast, monotonous fields should prompt us to rethink our approach. We must win such battles in the future if we are to increase our food supply while alleviating ecological consequences at the same time.

There will be many different roads to success in plant breeding and farming

The roads to success in these areas are many, and we must pursue them all. In the first stage of fascination with the new technologies, a number of other pest-control strategies lost much – too much, in my view – of their appeal. Modern agriculture could benefit enormously from the knowledge and experience of organic farmers, whom I regard as visionaries of no less importance than the genome researchers who bring us this progress. We should apply our new knowledge about individual genes constructively to methods of cultivation that preserve or enhance soil fertility while preventing the growth of even small weed populations and offering refuge and food for beneficial insect species. On the basis of our new, sophisticated genomic knowledge it should be possible to develop transgenic plants capable of defending themselves against pests by producing their own organic pesticides, substances that remain active for a limited time only and, ideally, perform their functions only in specific endangered organs. Scientists are now looking for means of controlling genes in such a way as to prevent the formation of these effective ingredients in plant reproductive organs. In this way, the risks involved in crossing out undesirable genes could be elegantly avoided. Does this sound like a futuristic vision? Admittedly, it will take several years to accomplish many of these improvement, but thanks to the breakthrough in genome decoding, such dreams are now within reach.

We should take the unique opportunity to pursue this ecological approach to plant breeding. This will require active co-operation with those organic farmers who are at least willing to entertain the possibility of incorporating other genes in their crop plants. At present, the market has nothing to offer organic farmers as an encouragement to join this still modest faction. Although lower pesticide and herbicide consumption is often cited as an argument in favour of these first transgenic varieties, most organic farmers are hardly impressed, as they have long since cut back the use of chemical agents substantially (albeit in favour of organic pesticides, which are not without significant problems of their own). Yet organic farmers frequently fail to think far enough ahead. They should not be indifferent to the fact that the transgenic, herbicide-tolerant soy bean permits a form of crop cultivation in which plowing is virtually unnecessary – a giant leap forward in the battle against soil erosion. Like conventional farmers, organic farmers can ill afford to reject potential improvements out of hand on dogmatic principles. After all, yields in long-term organic field trials are still comparatively low, and it is in the best interest of those directly concerned to seek improvements.

On the other hand, we now know that soil organisms flourish considerably better in organically farmed fields, a fact that should give the defenders of conventional farming methods pause for thought. I have learned from my own personal contacts that dialogue is possible, although it is clear where at least one of the problems lies. With their heavily ideological point of view, many organic farmers tend to isolate themselves excessively from modern developments. All official advocates of organic farming categorically reject the introduction of other genes into crop plants, for example. They are quick to support the superficial fear-mongering arguments of non-government organisations that do not even hesitate to fuel resistance to transgenic livestock feed in the face of firmly established scientific knowledge. My own personal experience has shown me that dialogue is possible and that even the most dedicated organic farmers are capable of learning as well. My own surname can be traced back in a straight line to the Anabaptist founder of the Amish community in the US state of Pennsylvania – a certain Jakob Ammann, one of my direct ancestors, who's name has been used to denominate the 'Amish'. This courageous emigrant, like so many others a victim of a broad and brutal campaign of religious "cleansing", established the Mennonite sect in 1693 and laid the cornerstone for the many Mennonite village communities now found throughout North America. These groups have preserved not only their religious beliefs but their traditional organic farming methods as well.

Those who see these Amish farmers as stubborn learn in their first personal encounter with them that such is not the case. One is amazed at how deeply curious the Amish are. I can confirm, at any rate, that the friends I have been privileged to meet do not fit the stereotype of narrow-minded fanatics. As organic farmers, they do not reject technology out of hand but instead examine every innovation closely in an effort to determine whether it might pose a danger to their religion or way of life. If they are convinced of the potential benefit, they have no reservations about introducing milk cooling systems and other modern technologies. I had a number of surprisingly amiable, objective discussions with Amish organic farmers about genetic technology, and to my amazement, they decided to test samples of genetically modified seeds soon afterwards. Transgenic potatoes are currently being grown on a trial basis on their farms. And there is no reason whatsoever to suspect that these genetically altered potatoes might disrupt their religious and social system in any way at all.

I have no way of knowing whether the Amish will actually begin cultivating these new varieties of potato in earnest, and that is ultimately their decision alone. But I was impressed by how quickly these very traditional Amish farmers, of all people, accepted the idea of testing the new varieties of potato. As I learned later, the laudable pragmatism that characterises their approach to such difficult issues is a function of their unique spirituality and the strong sense of security they derive from their religion.

I have gained a very similar impression in conversations with practising Buddhists. Their natural curiosity and their willingness to consider even genetic technology without prejudice has fascinated and impressed me time and time again. The most striking example of such a seminal conversation I have ever experienced took place in the Botanical Gardens at the University of Bern, where I had the good fortune to spend a half-hour discussing genetically engineered crop plants with a dignified yet quite cheerful teacher of the Dalai Lama. He, too, exhibited neither prejudice nor fear with regard to this visionary technology that is unfortunately much too often condemned without a hearing in this country.