Plant Biology in The Service of Mankind and His Environment

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A responsible society, which concerns itself not only with the wellbeing of its present population but also with future generations, must not ignore or hinder progress in plant biotechnology. On the contrary, society must encourage new advances. Even in the near future, agriculture, whether global or regional, whether intensive or extensive, whether industrial or familial, will no longer be optimally productive without an important contribution of new scientific knowledge and without responsible application of the best and most effective technologies.

In this talk on the occasion of the 1998 Japan Prize in the field of Biotechnology in Agricultural Sciences I shall begin by giving a brief review of the scientific discoveries which underlie present day plant biotechnology. I shall then discuss the potential of plant biotechnology to contribute to the solution of current and future problems. I will conclude with an evaluation of the public debate regarding the value to society of research, both fundamental and applied.

Two scientific breakthroughs underlie genetic engineering in plants. First was the development of recombinant DNA technology which made it possible to isolate individual genes from any organism. The second was the discovery that there are bacteria in the soil, *Agrobacterium tumefaciens*, which transfer genes into plants. This was the first documented instance of genetic engineering in nature. *Agrobacterium tumefaciens* bacteria modify the properties of the host plant cells to their own advantage by introducing new and specific genetic elements into the genome of the plant cells. This work provided the basis for the development of vectors and methods for the introduction and expression of novel and modified genes in plants and opened the way for molecular plant breeding. Such vectors and methods have thus far also been important in the elucidation of plant cell development and the role of plant hormones and could be used to revisit and further develop many aspects of Plant physiology, -biochemistry, and even -taxonomy and -ecology.

To evaluate the possibilities of plant biotechnology one should keep in mind the following:

1. Agriculture, as it is practised currently, is one of the biggest sources of environmental pollution. Continuation of these practices can lead to rapid and possibly irreversible deterioration of the environment, thus putting the sustainability of agriculture in question.
2. Agriculture must be productive in order to be commercially viable, and socially and environmentally acceptable. If agriculture is to remain an attractive occupation, it must be economically rewarding. If one wants to diminish the negative impact of agriculture on the environment, one should optimize productivity, i.e. maximum quality and yield for a given input, such that one can reduce input and at the same time conserve or even improve quality and yield.
3. Plant breeding is one of the few, and one of the most effective methods, to improve agricultural productivity without simultaneously destroying the environment. This is true for the industrialized world, perhaps even more true for the developing world and holds for both intensive and extensive agriculture.
4. If plant breeding is to contribute to the solution of the enormous problems which we must face in the next decades, then the best techniques must be used including genetic engineering. The resulting plants must then be compared to already available crops for their effect on health and on the environment.

In relation to gene technology in particular one must remember:

1. Transgenic plants and microorganisms can help to diminish the negative environmental

effects of intensive agriculture.
2. Several thousand tests in the field have already been carries out around the world and have given no indication of real dangers or consequences which had not been predicted.
3. Transfer of genes occurs in nature (as in the case of *Agrobacterium tumefaciens*).

Gene transfer into plants and marker assisted breeding can contribute to four overall goals in plant biotechnology.

1. change the characteristics of plant products
2. improve plant resistance to pests, pathogens and abiotic stresses
3. increase output
4. produce unique metabolites e.g. pharmaceuticals, vaccines

New science and technology are viewed with caution and indeed fear. This is particularly pronounced in Europe. Unfortunately, precisely the organizations and political parties whose support is based on environmental protection and on providing optimal social conditions, have been most active in rejecting plant biotechnology. The potential of this new technology to protect the environment has been largely ignored. On the other hand, experience gained from the use of nuclear power, e.g. Chernobyl, as well as the pollution resulting from the use of chemicals make clear that new technologies can bring new and unexpected dangers. Regulations, therefore, are necessary but should be rational, based on solid facts and considerations. Even more important is the development of informed public opinion through education and objective reporting by the media.