75th Anniversary
Royal Academy of Overseas Sciences
Brussels, 9 & 10 October, 2003
pp. 75-81 (2004)

Capacity Building and Technology Transfer in Plant Biotechnology for the Developing Countries

by

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Last year at the World Summit for Sustainable Development, the International Council for Scientific Unions (ICSU) made a very strong statement on the importance of science and technology for development of the "Third World Countries" (TWCs). I fully support this vision.

Governments of the rich countries, international agencies, charities and foundations active in international cooperation, should give priority not to AID, but to capacity building of these TWCs for them to acquire the know-how for industrialization and improvement of agriculture, health care and environment. Joint R&D efforts with our institutes in the developed world can create the novel plants that can bring value to agriculture and stimulate the establishment of a local seed industry.

The enormous progress in plant genomics and metabolomics makes it possible to construct plants as starting material for the chemical industry (bulk products and fine chemicals). This with the aim of creating an industry that is less dependent on petroleum as starting material. Exploiting together with the TWCs their rich biodiversity, and stimulating the industrial development in the developing countries, can be an important base for initiating economic development. Creating value for tropical agriculture, while taking care that women participate in this economic development, bringing an affordable medicare through drugs produced by plants, remediating industrial pollution with specialized

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plants, all this can be realized through plant gene engineering and associated "smart breeding".

It is imperative that we associate the TWCs with this R&D in life sciences. We have to give them access to the 21st century technology and associate their universities with the capacity building of the developed nations.

The economic progress that will result from such an endeavour can create the financial wealth necessary for allowing favourable society adaptations. At that moment it will be possible to bring the necessary political changes and demonstrate the value of democracy and the value of humanistic principles that helped us to settle disputes in a peaceful way.

1. What are the Technologies of Life Sciences, or Biotechnologies bringing ?

Today one talks about the red (medical), green (agricultural), white (industrial) and blue (environmental) biotechnology. It is important that we, as scientists, as well as the society at large and particularly our leading politicians are aware of the achievements and potentials of these biotechnologies. Only then it will be obvious that we have to implement them in the TWCs without delay.

Most of the important new drugs developed in the last decade were obtained through the "Red Biotechnology". Either the drug itself is produced by a recombinant (gene-engineered) organism or the activity screening was made through recombinant target proteins. The fast progress in medical molecular biology guarantees that this trend will increase. Efficient drugs against the major tropical diseases like malaria, leishmaniasis, Chagas' disease, can be created through gene cloning and transgenic organisms. In fighting cancer the use of therapeutic proteins such as specific monoclonal antibodies is very promising. The production of these proteins through mammalian cell cultures is however very expensive. For developing a medicine affordable by the poor and particularly by the population of the TWCs, alternative production schemes, like production in transgenic plants, will be needed. Very promising *in vitro* results have been obtained in the production of diagnostic and therapeutic proteins in plants. The extensive biosafety tests required by the regulatory agencies are underway, so that commercial production can be expected in the coming years. Plant biodiversity will also be extensively

exploited. Major breakthroughs in analytical organic chemistry allow now a display of most of the different metabolites (metabolome) present in a given small amount of tissue. Together with the genomics progress, this can lead to identifying the biosynthetic pathway of a given active compound discovered in a medicinal plant used by aboriginal cultures. The possibility exists to engineer this pathway in a plant easy to cultivate and produce the compound through a specialized high valued agriculture, as such saving many rare and endangered tropical plant species. If the construction and production of these "Pharm" plants is done together with the TWCs, this can be the start of a new economic development. Furthermore, the demonstration that it is becoming possible to identify and capture the value of biodiversity, might convince governments of TWCs that they should protect the major source of biodiversity, the Tropical Rainforest. The present ongoing, nearly systematic, destruction of these forests is highly damaging for our planet. Ecological genocides should be recognized by all as a crime against humanity. Let us hope that this is a point where green activists and biotechnologists will once join and cooperate.

The green biotechnology has already brought some major products of great importance to agriculture of the TWCs. The insect-resistant crops like corn, soya and particularly cotton bring both increased yield and financial return by the use of much less insecticides. They are also environmentally friendly since they do not inflict the "collateral" damage, killing of beneficial insects, as is the case of massive insecticide spray. All cotton-growing countries want access to this GM-cotton. The same principle could be applied to the many crops typically grown by TWCs. Many of them like cowpea and Andian potatoes are very prone to insect attack. The tools to engineer the insect-resistant varieties are available. We should organize networks so that the technology is transferred to the TWCs and that for each area the locally adapted cultivars are transformed and enter improved breeding programmes.

The herbicide-tolerant crops are also an economic and ecological success. Both in the developed world and in the emerging countries where large-scale agriculture is practised. After Argentina, Brazil and South Africa, China, India and the Philippines are now introducing them as well. The use of these types of GM-crops, like the "Round-Up" tolerant corn, soya and wheat produced by Monsanto, does not only procure a higher yield, but it makes a non-tillage agriculture possible and allows the late emerging of weeds (when the "Round-Up" is degraded by the soil microorganisms). In that way insect biodiversity and wildlife can develop better than when conventional herbicides are used.

The irrational but very aggressive opposition against GM-plants, present in Europe, has led to a very complex and expensive legislation. Activists try to export this refusal of GM-crops to the developing countries. The confusion raised these last ten years, has already severely blocked the construction of further beneficial GM-plants.

Nevertheless, the success in fundamental research indicates that it soon will be possible to use plants resistant to nematodes, to some major virus infections and also plants better resistant to some bacterial and fungal attacks. Also improved resistance to abiotic stresses is available in some prototype plants. It concerns the engineering of better drought, salt, heat and cold tolerance. Major crop plants of importance to TWCs, such as rice and cassava, can be engineered for stress resistance. Great efforts are now concentrated on the construction of new materials in plants. This can go from new starches, lipids and improved production of cellulose up to the production of new monomers for producing biodegradable plastics or new textile fibres.

These types of plants will be the base of a sustainable industry in the coming decades. Solar energy replaces the petroleum-based productions and these plants can bring a higher revenue to agriculture. The high diversity of crop plants in TWCs is a great opportunity for these countries to join this effort by developing very novel production schemes for bulk and fine chemicals.

The white biotechnology, mostly focused on production of industrial enzymes, will also be of paramount importance to the TWCs. Industrial production schemes working at lower temperature by using the right catalysts (enzymes) would be an essential asset for energy-poor countries. India has already shown that they can be leading in fermentation technology. Good informatics and microbial experimentation will allow the design of novel enzymes. These are assets of resource-poor countries if we participate in their capacity building. It is indeed very unwise for the developed world not to use 90 % of the brain capacity of our planet, at the moment when the need for a less polluting industry is so high.

The blue technology is only in its starting phase. Mostly because the scientists who have best studied the damage done to our planet, namely the ecologists, are ideologically reluctant to accept gene engineering as a tool in engineering solutions for environmental problems.

Life sciences are best situated to remediate the past and future damage. Until now mostly physical and chemical approaches have been tried to clean and decontaminate polluted sites or waterways. But the financial costs are immense, the scale of application is limited and by proceeding

in this way, often waste disposal problems remain, as they are only shifted to another location. Good success has been obtained by engineering microorganisms and plants that can catabolize or concentrate polluting chemicals or heavy metals. Based on these accomplishments, a series of start-up companies specialized in bio- or phytoremediation have been established. TWCs with their ongoing population increase and urbanization into gigantic megalopoles badly need affordable waste treatments and decontamination of industrial sites. The developed countries should take the initiative to support our scientists so that they can bring the necessary know-how and initiate a pollution remediation industry in TWCs.

2. The Urgencies

After World War II we were 2 billion on our planet. A good fifty years later, we were 6 billion. Soon we will be 7 billion and although the population is stabilized in most of the developed countries, which will then represent 10 % of the world population, the increase in the TWCs, particularly among the poorest, is very alarming.

At present more than half of the world population has to live on less than 2 € a day. Out of them an 800,000 live under malnutrition or starvation. To break this vicious circle of poverty and starvation serious investments should be done in bringing technological development to the TWCs. The potentials of the new biotechnologies can create value for their agriculture and stimulate sustainable industrial activities. In many places in rural Europe, particularly in Flanders, people were also living in TWCs' conditions until the first decade of the twentieth century. Technological improvements allowed the workers' organization to negotiate the necessary improvements and in three decades most of Western Europe reached living characteristics for the developed world.

How can such technology transfer to the TWCs be financed ? It is not the leading multinationals based in the developed world which will sponsor this. But once the industrialization starts in the TWCs, they will join and stimulate the trend. For initiating the movement we will have to count on the international cooperation departments of governments, private charities and foundations as well as on initiatives of multilateral international organizations. However, the funds available are very limited, so one will have to depend on the generosity and dedication of individual scientists to start this cooperation.

Let us hope that the discussions concerning the TWCs on the abolishment of the agriculture subsidies in the developed world, subsidies that

reach one billion $ a day (375 billion $ a year), will succeed and that part of this money can be used to start a massive effort for capacity building and technology transfer in biotechnology towards the TWCs.

3. What can Academies do ?

Mostly all Academies, learned societies and professional unions of scientists, consider it as their task to explain the importance of the methods of science and the research results to society. They also try to stimulate the younger generations to join this quest for knowledge and to participate in the ongoing attempts to construct fairer and more peaceful societies.

So I believe that these organizations are well placed to explain the molecular life sciences and their applications "the biotechnologies" to our societies. They can play a major role in increasing substantially the public acceptability of these biotechnologies.

The contributions of the Academies can be at many levels. They can stimulate capacity building worldwide, insisting that AID to the developing countries should in priority be aid to acquire the skills to participate in the production process and not a mere gift of food, goods and consumables. The Third World should have access to R&D expertise so that they can be the driver of their economic development. But capacity building includes training in business management, international regulations, compliance to the biosafety tests, and intellectual property management. Worldwide, Academies should explain the potentials and the risk benefit balance of novel sciences to the society at large. They also should take care that all citizens of the planet Earth have access to the evolving knowledge and the resulting technologies. They should stress the importance of protecting our environment and the dynamic equilibrium between living organisms, a challenge for which biotechnology is bringing us the tools. Finally, they should defuse the aggressive nature of the actual misunderstanding around transgenic plants since it is very dangerous for our democracies if governments continue to let action groups destroy field trials of transgenic plants.

On the occasion of their 75th anniversary I would like to congratulate the Royal Academy of Overseas Sciences for having organized this symposium. It is essential that our science community be aware of the needs and potentials of the Third World scientists. It is important to stimulate our scientists to take initiatives for making R&D networks around topics

of great urgency for the economic and society development of the Third World.

I hope that further discussions among the participants to this Symposium will create confidence that we have the tools and the know-how, to progress successfully with such network building. If we present a coherent strategic plan to our government authorities, to the Charities and Foundations involved with Global Aid, I am confident that we will obtain the funding for such R&D cooperation. At present the most urgent action however will be explaining to society why such a science and technology action is needed for obtaining a sustainable development.