
Prospects of agricultural biotechnology for marginal areas

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Mr. Chairman, Ladies and Gentlemen. It is a distinct honor and privilege for me to speak to you today on a topic which may find relevance in your deliberation in the next two days.

At the outset let me recognize that there may be a number of other modern technologies that might be applied to promote agricultural development in the marginal areas of monsoon zone but for today's lecture I would like to restrict my scope on the prospects and potentials of employing biotechnology as a tool in increasing crop production in these areas.

As has been pointed out, marginal areas of monsoon Asia are characterized by geographical diversity such as mountainous, semi-

arid and rain-fed areas, forest margins and wetland areas, which extend from the Himalayas and Southeast Asian inland areas to coastal areas and the Korean and Japanese mountain ranges.

Marginal areas share the common characteristics of inadequate soil fertility and water stress, low agricultural potential, and difficult access to commercial inputs, yet have very complex and diverse natural and socio-economic conditions. These areas rarely benefited from modern technologies and the majority of the inhabitants are still suffering from poverty and environmental degradation.

Ladies and Gentlemen. Since this symposium is being held at the United Nations University, may be it is good idea to reflect somewhat on the Millennium Development Goals and Targets agreed upon by world leaders at a Summit at the United Nations in 2000. The eight goals are eradicating extreme poverty and hunger; achieving universal primary education; promoting gender equality and empowering women; reducing child mortality; improving maternal health; combating HIV/AIDS, malaria and other diseases; ensuring environmental sustainability, and developing a Global Partnership for Development.

These goals and targets were reaffirmed at the 2002 World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa and the UN Secretary-General Kofi Annan proposed that the global community focused on five key thematic areas of Water, Energy, Health, Agriculture and Biodiversity (WEHAB) that are integral to a coherent international approach to the implementation of sustainable development.

Agriculture plays a crucial role in sustainable development and in hunger and poverty eradication. Some 70 percent of poor and hungry people in developing countries live in rural areas and depend directly or indirectly on agriculture for their livelihood.

However, natural resource constrain is one major factor in making agricultural intensification and growth a vehicle for sustainable hunger and poverty reduction. Arable land per person in developing countries has shrunk from 0.32 hectares in 1961/63 to 0.21 hectares in 1997/99 and is expected to drop to 0.16 hectares by 2030. At the same time, several processes are contributing to declining quality of land resources. Soil erosion is responsible for

about 40 percent of land degradation worldwide, while 20-30 percent of irrigated land in developing countries has been damaged by water-logging and salinity. Extreme poverty and hunger push people onto marginal lands and more fragile ecosystems characterized by drought stress and low soil fertility.

True, over the past 30 years, agricultural productivity growth resulting from successful agricultural research and development meant food production in developing countries tripled, outstripping population growth. Over the same period, the proportion of undernourished people dropped from 35 to 17 percent, real prices of the main cereal crops declined dramatically and poverty decreased. The question is whether these successes can be repeated in the marginal areas, and using biotechnology as an adjunct to conventional plant breeding.

Agricultural biotechnology has been changing the face of agriculture since its commercial introduction in 1996 and the widespread adoption of genetically engineered crops by farmers in the United States and other countries. According to the latest briefing from the International Service for the Acquisition of Agri-biotech Applications (ISAAA) the estimated global area of transgenic crops in 2002 is 58.7 million hectares (145 million acres), grown by about 5.5 to 6.0 million farmers in 16 countries, up from 5 million farmers and 13 countries in 2001.

However, this technology is not without controversy and is causing political reverberations around the world. A legally binding international instrument, the Cartagena Protocol on Biosafety took effect one month ago (11 September 2003) governing the transboundary movement of living modified organisms resulting from modern biotechnology. The treaty was adopted in January 2000 by member countries to the Convention on Biological Diversity (CBD).

One may asked what the fuss is all about? To be sure, humans have been manipulating and modifying genes of plants ever since the advent of agriculture some 10,000 years ago. Plants have been cultivated and crossbred by humans to produce offspring with specific, desired traits. For example, maize as we know it today barely resembles its ancestor, teosinte, or *Zea mexicana*, a tall grass that produces finger-length "ears" containing a single row of a few grains. Maize produced today has been cultivated for many years to serve as

a food crop, with far different traits than those of its predecessors.

When varieties are crossbred to produce a hybrid plant, thousands of genes are combined in the process. Scientists must select and continually crossbreed the plants, often over a period of several years, to obtain plants with the largest number of desired traits and the least number of undesirable traits.

Modern biotechnology is a tool that allows scientists to select a single gene for a desired trait, incorporate it into plant cells, and grow plants with the desired trait. In many ways, it is simply a “high-tech” version of conventional plant breeding. This is a more efficient process and is targeted as a specific gene; it prevents other genes from reshuffling and possibly producing undesirable traits.

Biotechnology offers a number of tools to identify, transfer or modify expression of genes of desirable traits. To just name a few, molecular markers have extensively been used in combination with conventional plant breeding system. Biotechnology in the comparative genomics and linkage map research are also powerful applied tools in boosting the ability of plant breeders to modify our crop plants.

These allow scientists to incorporate genes from other related species – something that cannot be done via conventional plant breeding alone. There are hundreds of commercial cultivars in use world wide today, produced by a mix of conventional plant breeding methods and use of biotechnology tools, carry the so called alien genes, that is a gene from a different but related species. Biotechnology yet provides the opportunity to incorporate useful genes from even non related and far distant species into our crop plants and produce the so called transgenic crops. Production of transgenic crops has so far been limited to simple traits under control of one gene such as insect resistance, multi-gene traits such as resistance to salinity or drought are more difficult to produce.

Some people fear this tool because it is perceived as “unnatural”. However, most people forget that the food crops we have today would not exist without man’s intervention, whether through plant breeding, fertilizer application, delivery of irrigation water or use of modern tractors and equipment. Without cultivation by man over the years, we would still have teosinte instead of conventional maize. The same is true for wheat, tomatoes, potatoes,

watermelon and any product on today's supermarket shelf. Thus, biotechnology is simply a modern, additional tool in the long history of plant cultivation and agriculture.

Ladies and Gentlemen. Let me now try to give you a snapshot on some of the advances made in plant biotechnology using molecular biology or genetic engineering techniques with the objective of crop improvement. Some of the following examples may have relevance in alleviating agricultural under-development in marginal areas.

India's GM rice: Scientists at the Directorate of Rice Research (DRR) in Hyderabad have undertaken a research that would produce genetically modified (GM) rice that has resistance against six diseases. The GM rice is hoped to have the capability of protecting itself against stem borers, brown plant hopper, gall midge, blast, sheath blight, and bacterial leaf blight. The durable, multiple-pest resistant rice is expected to be ready for the market by 2006. The six diseases mentioned contribute to significant financial losses since rice is being cultivated in about 45 million hectares in India. At present, the DRR is in the process of developing the GM rice variety by inserting genes against stem borer and gall midge, and crossing it with other varieties.

GM corn with increased Vitamin E content: Scientists from the United States Agricultural Research Service have developed a new method of engineering plants like corn to contain significant levels of the antioxidant Vitamin E. The researchers isolated the genes that encoded enzymes to increase the production of Vitamin E up to 10 to 15 times more than non-engineered plants. Additional benefits of the discovery, when the process is refined, include plants that will be more resistant to oxidative stresses, leading to seeds that can be stored longer and improved crop productivity. In addition, vegetable oils manufactured from the seeds would have an extended shelf life.

GM sweet potato in Kenya: Research is being done in Kenya to develop a GM virus resistant sweet potato for use by subsistence farmers. It is considered a promising option towards the control of the sweet potato virus disease (SWVD) which accounts for about 80% yield loss.

GM plant vaccine for asthma: Australian researchers are making progress in what may lead to a plant vaccine for asthma. They were able to produce GM lupin (a genus of plants belonging to the pea family) that suppressed asthma in mice. The researchers expressed a sunflower seed albumin protein in lupin, and demonstrated that this could stimulate antibody production in mice, and lessen the hypersensitivity associated with experimentally induced asthma. The data suggested that a GM plant based vaccine can promote a protective immune response and attenuate experimental asthma, implying that plant based vaccines may be potentially therapeutic for the protection against allergic diseases.

The above are just but a few examples of GM technology in crop plants. The current agricultural biotechnology products mainly involve crops that are engineered to resist pest attack and tolerate herbicides. The most widely grown crops globally include soybeans, maize, cotton and canola which together, account for more than 90 percent of the area planted with transgenic crop.

One area of concern in terms of applicability of biotechnology to developing countries, let alone in marginal areas, is the large role of the private sector in biotechnology research, the dominance of private sector research by a few firms, and the extensive patenting of research tools and genes. As a consequence, this would lead to the neglect of poor people's crops and poor regions; the impact of intellectual property rights and the possible use of genetic use restriction technology (GURTs) on accessibility of technology and genetic resources to developing country scientists and farmers; and potential monopoly power of the biotech firms and their ability to extract profits from farmers.

There is a dire need to undertake research in biotechnology and plant breeding that would benefit the poor. The traits needed to improve the condition of the poor farmers such as increasing crop yield potential, increasing stability of yield through enhancing crop resistance to biotic and abiotic stresses. One of the traits that may not be so important in a land scarce area grown by farmers in labor abundant economies and where hand weeding is a source of employment is herbicide resistance. Whereas herbicide resistance has been a major field of biotechnology application in agriculture,

designed mainly for developed countries market. Therefore targeting biotechnology to the needs of the poor requires to focus the research on their needs and their basic staples such rice, wheat, white maize, cassava, yam and millets. The farmers targeted should be small farmers, who have limited access to land, machinery, and chemical inputs and not the large commercial farmers in the industrialized or developing countries.

Most of the major biotech companies have been reducing the number of crops that they work on as their research budgets shrink. Monsanto, for example, now focuses their research on four crops: maize, soybean, wheat and cotton. It has stopped research on major crops like rice and potatoes, which used to be major research crops.

There is, therefore, an urgent need for the public agricultural research systems of developing countries and the International Agricultural Research Centers (IARCs) to harness the benefits of biotechnology for the small farmers. At present, the only public sector successes in developing transgenic crops for poor farmers are Bt cotton produced by the Chinese Academy of Agricultural Sciences. Several of the IARCs are involved in developing biotechnology applications, including transgenic varieties, aimed at poor farmers, but these efforts need to be strengthened.

More studies are needed on the economic, environmental and health benefits and concerns that poor farmers face from biotechnology and alternative technologies. Such research can help answer some of the remaining scientific questions about the safety of transgenic crops and can help people compare them with existing alternative production systems.

Programmes that educate farmers and consumers about the potential benefits and risks of biotechnology can empower people to make informed choices.

Transparent biosafety regulations can help ensure that appropriate regulatory decisions are made and can reassure people that they are protected from unacceptable risks.

However, to make things happen in developing countries, especially to promote and accelerate agricultural development in the marginal areas, a set of systemic framework needs to be put in place at the national level.

The UN General Assembly Economic and Social Council

recently outlines the following proposals for biotechnology development and technology acquisition. Any national biotechnology development strategy should consider the following common features:

- Clear Government plans to develop a biotechnology industry with benchmarks (number of scientists trained, products developed and technologies acquired) on activities to be attained by each stage of development.
- Establishment of biotechnology related programmes (research, development and marketing) in universities and national research institutions.
- Involvement of the private sector in planning the biotechnology development agenda through matching funds, sharing facilities and technologies.
- Establishment of international collaboration and partnerships for research and development, production and marketing e.g., technical cooperation.
- Provision of public venture capital to fund small start-up firms and commercialization of research products.
- Policies and programmes that simulate entrepreneurship in public institutions and investments. These include policies on commercialization and ownership of knowledge and allowing scientists to interact freely with industry.
- Incentives for public private partnerships. These include government contracts, directives on publicly funded projects and international strategic partnerships.

In conclusion, let me say that biotechnology has to be part of the global fight against poverty, hunger, disease and underdevelopment. It is not a question of whether it will deliver the promises but how the promise of biotechnology will be shared. It is in the interest of humanity, in developed and developing countries, that biotechnology applications are used as widely as possible.

Let me conclude by thanking you for listening and I wish you a very fruitful and successful symposium.