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***Background Brief***

# Promethean Science
## Agricultural Biotechnology, the Environment, and the Poor

Prometheus, according to Greek mythology, was a Titan, responsible for introducing fire to humans, a remarkable innovation in its time, but having benefits and risks, depending on its use. Promethean has since come to mean *daringly original and creative*.

Today, the Human Genome Project is providing a major impetus to understanding the genetic basis of life. Biotechnology-based processes are now used routinely in the production of most new medicines, diagnostics, and medical therapies that offer hope to people with AIDS, genetically inherited diseases, diabetes, influenza, and cancer. They also underpin new international health efforts, such as the children's vaccine initiative, that are mobilizing expertise and financial resources of governments, several international agencies, private foundations, and the pharmaceutical industry. These are expected to lead to future major improvements in human health worldwide. Modern science offers the potential for similar major contributions to improving food security and nutrition of the poor.

*The need to produce and improve access to sufficient food for the world's population over the next 20 years is as urgent, compelling, and complementary to improving human health.*

About 73 million people will be added to the world's population every year from now until 2020. Meeting the food needs of this growing and increasingly urbanized population requires increases in production and productivity and matching these to dietary changes, including the increasing demand for livestock and fish. World grain production alone will need to increase by 40 percent by 2020. Without new developments in increasing productivity, food insecurity, and malnutrition will persist to 2020 and beyond. There are likely to be 135 million malnourished children in 2020, 77 percent of whom will be living in Africa and South Asia.

The most promising approaches to increasing productivity on small-scale farms are agro-ecological approaches, albeit recognizing the potential role of modern biotechnology, and the use of new information technology and precision farming. It will require the successful integration of all three approaches to achieve the full potential of modern science and ensure the necessary increases in production while conserving the natural resource base.

Large private sector investments in agricultural biotechnology are directed at traits of interest to producers and consumers in industrial countries. The current debate over the value and safety of these new products is also dominated by the perspectives of civil society in industrial countries. The potential value of modern science to agriculture and the environment in developing countries will not be realised without major additional efforts involving all stakeholders, including civil society, producers, consumers, and governments.

Several emerging economies (including Argentina, Brazil, China, India, Thailand, Kenya, and South Africa, amongst others) are making major investments of human and financial resources in biotechnology with the aim of using these new developments in science to improve food security and reduce poverty.

There is a need for major additional global efforts *to mobilize the new developments in science and technology that, along with better policies, are needed to increase sustainable productivity and improve access to food*.

In terms of the world's agriculturally important species, twelve crops (banana/plantain, cassava, maize, groundnut, oil crops, millets, potato, rice, sorghum, sweet potato, soybean, wheat), five species of livestock (cattle, goats, sheep, pigs, and chickens), and fish species provide approximately 95 percent of the food in the developing world.

**Several actions are urgently required**:

1. *Plant and Animal Genomes*: Ensure that the descriptions of genomes of the world's agriculturally important species are genetically mapped and that this information is put in the public domain, able to be used widely to generate improved varieties and breeds adapted to local ecosystems, and useful biological products.

2. *Identify Priority Traits*: Identify the genes conferring traits that are important to poor producers in marginal environments. Some, such as drought tolerance in cereals, appear likely to be shared across species. This knowledge would greatly accelerate breeding for these difficult traits and enhance the ability of the target crops to be more productive in difficult environments.

3. *Conserve and Characterize Genetic Resources*: Maintain and characterize the farm animal and plant genetic resources of the world's major agricultural species. A recent

review of the CGIAR's in vitro collections suggests that it will require US$70 million to upgrade the present plant collections, and thereafter US$8 million per year to maintain them. According to FAO studies, additional investments are required to collect, characterize, and conserve farm animal genetic resources. The collections of plant and animal genetic resources, and the biological information pertaining to them, are a vast resource for genetic improvement and the identification of useful traits. There is an urgent need to ensure that these collections are financed in a more sustainable way so as to ensure that the genetic resources of the world's major agriculture species are conserved, characterized, and accessible for use, in perpetuity.

4. *Access Enabling Technologies*: Obtaining access to proprietary technologies is key to the successful applications of biotechnology to agriculture in the developing world. This will enable the characterization and application of useful genetic information for crop and livestock improvement and the integrated control of pests, parasites, and pathogens.

5. *Establish Strategic Alliances:* A concerted international effort is needed to establish a new compact between the public and private sectors of the industrial and developing countries, so that the new developments in modern science are able to be used more effectively.

6. *Increase Investments in Agriculture*: Significant additional investments by the public and the private sectors are required if agricultural productivity is to increase in the developing world in an environmentally sustainable way.

7. *Provide Incentives for Private Sector Participation and Partnerships*: Incentives are needed to encourage the private sector to address the problems of agriculture and the environment in developing countries, for mutual benefit.

8. *Mobilize the Global Scientific Community to Address the Problems of Food for the Poor*: The CGIAR centers presently invest US$25-35m each year on agricultural biotechnology, out of a total CGIAR budget of US$340 million. The CGIAR centers and the national agricultural research systems are also the repository of a vast array of knowledge of the biology of the world's major food crops, livestock, fish, and tree species and their associated pests and pathogens. International crop improvement programs are located throughout the world's major ecosystems. These scientific, biological, and financial resources are a powerful platform. They now need to be mobilized with the global scientific community in new and imaginative ways, if a quantum leap is to be made in improving agricultural productivity, food access, and livelihoods by 2020. The Global Forum for Agricultural Research may play an important role here.

9. *Identify Desired Outputs*: Innovations that are required to contribute to improved food security and to create wealth in the poorer regions of the world include: Improved genotypes and better agricultural practices to ensure sustainable increases in productivity; new biological products, such as vaccines, biocontrol agents, and diagnostics for the control of major endemic diseases of crops and livestock.

Achieving these outcomes will require marshalling and directing public and private financial and scientific resources in new ways, both nationally and internationally. Also, R&D advocated in the area of genetic and other productivity improvements must be seen in the context of improved agro-ecological, socio-ecomonic and gender-sensitive approaches.

10. *Challenges to the CGIAR:* The CGIAR must seek to invest in and mobilize the necessary human, financial, and biological resources to address the production, policy, and sustainability challenges. This will require the CGIAR to:

- Identify the researchable constraints
- Invest more and with a greater sense of urgency in science to solve problems, integrating the new understanding of agroecological issues with the new opportunities in genetics and biotechnology
- Build on traditional strengths in breeding, biology, genetic resources, and information management
- Analyze, interpret, and make more accessible the wealth of biological data
- Access new skills to achieve new goals
- Form purposeful strategic and project-specific alliances
- Create more flexible and innovative implementation arrangements that cut across traditional Center and institutional boundaries
- Provide financial incentives for innovation and reward success.

## Epilogue

Prometheus changed the world forever when he unleashed the forces of innovation and creativity. In considering the applications of new developments in science, the challenge is to find ways to maximize the benefits, while also seeking to understand and minimize the risks.

The economic concentration of investment, science, and infrastructure in industrial countries and the lack of access to the resulting technologies are major impediments to the successful applications of modern biotechnology to the needs of global food security and to create wealth for the presently poor people and countries. Creativity in finding solutions to these policy and institutional impediments to innovation are as important and challenging as new scientific discoveries, if the promises of Promethean science are to be realized.

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