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BRIEF 50

Voices and Views: Why Biotech?

Edited by
Mariechel J. Navarro
Director, Global Knowledge Center on Crop Biotechnology

No. 50 - 2015

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> We need to hear the voices of those who think technology has something to offer so that these can resonate to others and be part of a chorus that is able to make informed opinions and produce sustained action.

Preface

Nothing in life is to be feared,
it is only to be understood.

-Marie Curie

Public discourse or conversations on the process and products of science and technology need to be dynamic and sustained. This is important as society needs to be fully aware about the whats, hows, and whys of technology to enable it to make decisions on its use or adoption. Public support for such technology in turn is critical once we enter the realm of policy formulation and implementation.

Voices and Views: Why Biotech? is a collection of personal essays on individuals from all over the world who have followed the development of biotechnology and are convinced that it has a significant role to play in improving the quality of life. It is a compilation of different key stakeholders' viewpoints, which are meant to generate interest in the field, inspire, and inform decision makers and to contribute to a better understanding of why the technology deserves attention. In the same manner, the essays pose challenges that the technology faces with the intent to bring opportunities to the surface as well as identify potential avenues for development.

Thirty-two experts from Africa, Asia, Europe, and North America were interviewed face-to-face or through email by members of the biotech information network of the International Service for the Acquisition of Agri-biotech Applications (ISAAA). These stakeholders represent policy makers, scientists, academics, media practitioners, and farmers who are willing to have their voices heard amidst the cacophony of divergent opinions. The list includes a former science and technology adviser to U.S. Secretaries of State, a World Food Prize awardee, noted scientists, economists, journalists, and farmers from Burkina Faso, China, Egypt, India, Indonesia, Kenya, Malaysia, Pakistan, Philippines, Switzerland, Thailand, Uganda, the U.S., and Zambia. They answered these basic questions: How did you get into biotech? Is there a place or future for biotech in your country/the world? What is its impact? What are the prospects and challenges?

Respondents with technical background and exposure to biotechnology enumerate many benefits of the technology — from improving yield, reducing use of pesticides and toxic chemicals, decreasing soil erosion, and diminishing agriculture's carbon footprint; while increasing the nutritive value of major crops and generally playing a vital role in improving the quality of human life. They note many studies and peer-reviewed papers documenting these benefits that will contribute to meeting the food and agricultural needs of the future. One scientist, in fact, was able to get almost 4,000 scientists to sign an online declaration in support of agricultural biotechnology, of which 25 were Nobel laureates.

Unfortunately, there are challenges that the field is faced with as recognized by the experts. One is the small but committed group of critics who have instilled fear among consumers, policy makers, and governments through misinformation and widespread campaigns using scare tactics and unproven claims. The other challenge involves the strict regulations that have made development and approval of new biotech crops a very rigorous and expensive process. The experts likewise caution that, although

benefits have been considerable, if products fail to meet certain criteria, such as safety and efficiency, then there is no basis for supporting them. Likewise, the technology is to be regarded as merely one of other possibilities in the quest for better agricultural productivity.

Journalists, economists, and non-technical stakeholders all went through a process of discernment in their search for evidence-based answers. In seeking balance in their writing or analysis of information, they were guided by peer-reviewed articles, interviews with experts, exposure to farmers through field visits, and rejection of sensational and exaggerated claims not characterized by scientific rigor. They got into media reporting or the socioeconomic study of biotechnology only when they felt that the literature or actual field exposure supported the claimed benefits. Similarly, farmers' experiences with the use of the technology speak for themselves. Words fail them while they share the changes that the technology made in their lives.

We thank the 32 individuals, all experts in their respective fields, for being part of this project. Twenty-three authors and contributors made it possible to capture the experts' voices and views. Eric John Azucena provided the innovative layout and cover design while Ms. Teresita Rola did the final editing. The ISAAA staff led by Dr. Randy Hautea supported and gave various forms of assistance. In particular, Rhodora Aldemita, Kristine Tome, Ian Reaño, and Clement Dionglay reviewed and proofread the drafts.

This publication, to be made available in print and online versions, will be widely disseminated worldwide, particularly to policy makers in developing countries where the technology stands to benefit stakeholders the most. It is being released in time for the anniversary of the Millennium Development Goals which were formulated in 2000 to address issues of poverty and hunger.

We need to hear the voices of those who think technology has something to offer so that these can resonate to others and be part of a chorus that is able to make informed opinions and produce sustained action. The initial chords that this publication will make will hopefully contribute to a more dynamic exchange of narratives and encourage public engagement.

Mariechel J. Navarro

Technology for Humanity

Nina V. Fedoroff

- Eva Pugh Professor at the Pennsylvania State University (USA) and Distinguished Professor Emerita, King Abdullah University of Science and Technology (Saudi Arabia)
- Former Science and Technology Adviser to U.S. Secretary of State
- Former President of the American Association for the Advancement of Science
- National Medal of Science laureate in the field of biological sciences (USA)

> **“…molecular modification is the safest and most powerful technology we’ve ever developed for the daunting task of continuing to increase the amount of food for a growing population and doing it more sustainably.”**

Can We Feed 10 Billion People?

Mariechel J. Navarro

Science and technology have completely transformed agriculture in the last two centuries. Three key innovations proved critical: synthetic fertilizer, combustion engine, and genetics. First, the development of a method for converting atmospheric nitrogen into forms that plants can use (fertilizer) enabled man to produce more food for a growing population. Second, the invention of tractors powered by fossil fuels allowed machines to replace a lot of manual labor, thus allowing people to do things beyond just producing food. However, it is the exciting and amazing technology of genetic modification (GM) that has the potential to help feed an estimated 10 billion people in the not too distant future.

"The irony," however, says Dr. Nina V. Fedoroff, a professor of life sciences and biotechnology, and former Science and Technology Adviser to U.S. Secretaries of State Condoleezza Rice and Hillary Clinton from 2007 to 2010, "is that fear of the technology is drowning out its potential benefits."

Contrary to popular belief, almost all the food we consume is genetically modified. "Genetic modification is the basis of all evolution," Dr. Fedoroff explains, "and we have devised ways to accelerate the process."

Vast Literature on Biotech

Like most other plant scientists, Dr. Fedoroff has used molecular techniques for more than three decades and knows the vast literature on the technology. "There's plenty of evidence that using molecular methods to add, silence, and modify genes is less disruptive of both the genetics and epigenetics of plants than the methods used in the 20th century and before, be it controlled cross-breeding, tissue culture, or chemical and radiation mutagenesis. These are better and less disruptive methods than the ones we used before. That, combined with the astonishing growth of knowledge about plant physiology, biochemistry, and genetics, gives me confidence that molecular modification is the safest and most powerful technology we've ever developed for the daunting task of continuing to increase the amount of food for a growing population and doing it more sustainably."

> **"Genetic modification is the basis of all evolution and we have devised ways to accelerate the process."**

Unfortunately, "contemporary GM crops are being blamed for farm suicides in India, tumors in rats, autism, obesity, and even infertility — even after 25 years of government research and a European Union report stressing that crop modification by GM techniques is no more dangerous than conventional products. The fear is being fuelled by electronic gossip and organizations that exploit GM fears for profit," Dr. Fedoroff says. In a TEDx event in October 2014, she challenged the audience with the query: "Will we continue to ignore facts and cling to fear-based belief systems?"

The scientist and science adviser had earlier echoed this sentiment in a 2013 article in the journal *Trends in Genetics*. Similarly, she asked the question, "Will our interconnected civilization with its globalized food supply so readily available to anyone who can afford it really discard an essential technology based on electronic hearsay?" And, in *ScienceFocus*, she raised the issue of why people were "willing to be frightened by nonsense and so reluctant to be persuaded, even by mountains of evidence?"

Transposons and Evolution

Dr. Fedoroff walks the talk, having pioneered on plant transposons, particularly doing groundbreaking work on molecular characterization of maize transposable elements or jumping genes. "I cloned one of the first plant genes ever cloned, figuring out how to adapt the molecular methods that had been worked out in microbial and animal systems to plants. I became a plant biologist after I met Barbara McClintock and read all of her work. I decided it would be fascinating to understand her genetic observations at the molecular level, both the genetic and the epigenetic aspects." Barbara McClintock was the 1983 Nobel laureate in physiology or medicine for her discovery of mobile genetic elements. In 2013, Dr. Fedoroff edited the book *Plant Transposons and Genome Dynamics in Evolution,* which gives an overview of plant transposons from McClintock's time to today. The book analyzes the research literature on plant transposable elements and how transposons shape gene structure and regulation, as well as their role in evolution.

> **"If we throw away these important tools, we'll find it very difficult to improve sustainability while continuing to increase production."**

President George W. Bush awarded Dr. Fedoroff a National Medal of Science in the field of biological sciences in 2006, the highest award for lifetime achievement in scientific research in the U.S. Her research sought to understand and strengthen the mechanism that allows plants to withstand the environmental challenges of a changing climate.

She served as President of the American Association for the Advancement of Science in 2012 and is a member of the United States National Academy of Sciences, the American Academy of Arts and Sciences, the European Academy of Sciences, and the American Academy of Microbiology.

Dr. Fedoroff graduated *summa cum laude* in 1966 from Syracuse University with a dual major in biology and chemistry. She received her PhD in molecular biology from the Rockefeller University. At the Pennsylvania State University, she was appointed as a Willaman Professor of Life Sciences and as an Evan Pugh Professor, the university's highest academic honor. She is a Distinguished Professor Emerita at the King Abdullah University of Science and Technology in Saudi Arabia. Among other prestigious awards, she received the Outstanding Contemporary Women Scientist Award from the New York Academy of Sciences and the John P. McGovern Science and Society Medal from Sigma Xi.

Keys to Meeting Food Challenges

Dr. Fedoroff says the deepening physiological understanding of plants and animals and increasing availability of molecular tools provide the keys to meeting the challenges of food for a still growing population sustainably in the face of a warming climate. "If we throw away these important tools, we'll find it very difficult to improve sustainability while continuing to increase production. Genetic modification of plants and animals using molecular methods can decrease the use of toxic chemicals, decrease soil erosion, decrease food waste and spoilage, and decrease agriculture's carbon footprint, while increasing the nutritive value of major calorie crops. There's just no other way."

This won't happen, Dr. Fedoroff warns, if fear-mongering and vilification of molecular approaches continue. "That's what stands in the way of politicians and regulators doing the hard work of reexamining the stringent biotechnology regulations in the light of the decades of research that have accumulated since their establishment. The pipeline of innovation will open up only if the regulatory regime changes, making it possible for scientists in both public and private sectors to work on all the different agricultural plants and

animals used in the world. Today, that's both too expensive and too slow for anyone, except the big biotech companies working on the major commodity crops." Widespread public hostility to GM crops has led to the development of more complex regulations and, in many countries, has completely blocked GM crop introduction.

Challenges to Address

The author of *Mendel in the Kitchen: A Scientist's View of Genetically Modified Foods* says, "the science is quite clear, but major challenges need to be addressed: 1) make regulation blind to the modification method (there is no evidence that molecular modification is dangerous) and based solely on the nature of the crop and the modification, 2) change peoples' belief systems about modern molecular modification, 3) fund the kinds of research necessary to address problems and challenges earlier mentioned, and 4) set a government-subsidized facilities to test those crops developed by both public and private sectors deemed in need of testing."

To the question Can the world feed its growing populace?, Dr. Fedoroff is optimistic that "we can, if we think and act differently." She proposes the need to invest in technological innovations so that "we can give everyone a livelihood, enough food to eat, and a seat at the table."

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Photo credit: Penn State Science

Per Pinstrup-Andersen

- Graduate School Professor and Professor Emeritus of Cornell University (USA)
- World Food Prize laureate
- Former Director General of the International Food Policy Research Institute

> **“There is an important place for genetic engineering in efforts to promote agricultural development, reduce rural poverty, improve nutrition and ensure sustainable management of natural resources.”**

A Matter of Choice

Mariechel J. Navarro

"How, in all conscience, can the well-fed of the world, by turning what should be a choice into a global dictate, opt out of the new technologies that could provide the opportunity for all the world's people to be well-fed? "

In their book *Seeds of Contention* Dr. Per Pinstrup-Andersen and Ebbe Schioler pose this question. They forward the thought that hunger is not just about the lack of food or capital but more of a powerlessness or lack of ability to choose what food to eat, what agricultural products to use, and what technologies to adopt. "The poor should be given the opportunity to decide for themselves." The authors encourage a progressive approach of using scientific innovations such as biotechnology that have the potential to end hunger not as the sole solution but as part of the system where free choice reigns.

In 2001, Dr. Pinstrup-Andersen received the World Food Prize (WFP) for his contribution to agricultural research, food policy, and uplifting the status of the poor in the world. The WFP, given in honor of Nobel Peace Prize laureate Norman Borlaug, recognizes the achievements of individuals who have advanced human development by improving the quality, quantity, or availability of food in the world. The awarding committee noted that Dr. Pinstrup-Andersen's " major accomplishment has not been technical or scientific in nature; instead, it has been the recognition that true food security will come as much from reliable policy research and exchange and thorough policy implementation as it will from technological and scientific advances." Dr. Borlaug, in fact, noted Dr. Pinstrup-Andersen to be "one of the most influential economists and policy makers today" and "an outstanding spokesperson for effective economic policies for transforming agricultural production of food-deficit nations."

Dr. Pinstrup-Andersen has worked on the economics of technological change in developing-country agriculture, including the Green Revolution technologies, most of his professional life. He became interested in the opportunities for promoting agricultural development and improved food and nutrition security presented by the development of improved crop varieties through genetic engineering back in the 1990s, when he was director general of the International Food Policy Research Institute (IFPRI). It was through his leadership that IFPRI became the world's leading think-tank on hunger issues.

In fact, as early as 1993, Dr. Pinstrup-Andersen launched the 2020 Vision Initiative, the most comprehensive and ambitious research and dissemination program on global food security. 2020 Vision alerted the world to potential food security crises in the 21st century.

Checking on the Evidence

"What really interested me," Dr. Pinstrup-Andersen recollects, "was why something as promising as this was met with opposition by certain advocacy groups. I spent a great deal of time trying to understand both what genetic engineering had to offer small farmers and poor consumers and what was driving the opposition. The evidence that most of the advocacy groups that opposed genetically modified organisms (GMO) forwarded were reasons other than their concerns for health and the environment. This made me even more interested in trying to contribute to a more evidence-based debate and decision making. I believed then and I believe now that the misinformation and the resulting action (or lack of action) were and are harmful to low-income people's incomes, food security, and nutrition. While most civil service organizations are helping poor people, some multinational non-government organizations (NGOs) are doing more harm to poor

people than the multinational corporations they criticize."

Currently Graduate School professor and professor emeritus of Cornell University, Dr. Pinstrup-Andersen states that all potential solutions to the problems confronting poor people and natural resources must be considered and assessed for their potential benefits, costs, and risks. Some of these problems are best solved by means of molecular biology, including genetic engineering. He says that there are plenty of examples of gains from the application of genetic engineering in agriculture, food, and health.

The agricultural economist who pursued his degrees at the Danish Agricultural University and Oklahoma State University notes that the impact of genetically engineered varieties for cotton, maize, soybean, and some fruits and vegetables has been documented. "There is an important place for genetic engineering in efforts to promote agricultural development, reduce rural poverty, improve nutrition and ensure sustainable management of natural resources."

Challenges Ahead

"The prospects are excellent to further move science toward solutions needed to achieve and maintain sustainable food and agricultural systems and alleviate most food and nutrition insecurity," Dr. Pinstrup-Andersen opines. The main challenge is to overcome opposition among those groups who do not have to take the consequences of their action. National and international agreements to penalize irresponsible behavior by multinational organizations would be an important step. He cites the case of African governments who were told about the alleged risks of biotechnology by many European governments and transnational NGOs. They listened and did not permit their farmers to grow GM maize even if their counterparts in South Africa as well as smallholders in Argentina, Brazil, China, India, and other countries are already doing so.

Another challenge is to streamline and reduce the time used for testing, approval, and satisfying biosafety systems, without sacrificing the quality of the process and outcome.

The man's outspoken advocacy for the hungry people in the developing world resonates to this day. Having been raised on a farm in Denmark and having worked for several years as a farm worker, Dr. Pinstrup-Andersen knows what he is talking about. "I am a believer in the use of modern science to solve problems confronting people and the environment in which we live because I believe it is essential to achieve and maintain the world we would like for current and future generations." He says he is not aware of any evidence-based reason why genetic engineering is promoted for use in the health sector but opposed in the food, agriculture, and natural resource sectors.

Failure to use the best that science can offer will make it difficult and possibly impossible, he says, to deal effectively with existing and new plant and animal diseases and pests, including "those likely to develop in the slipstream of climate change and the doomsday predictions that the world cannot feed future generations may actually materialize." Dr. Pinstrup-Andersen warns that "if that happens, it will be due to our failure to behave rationally."

Further Reading

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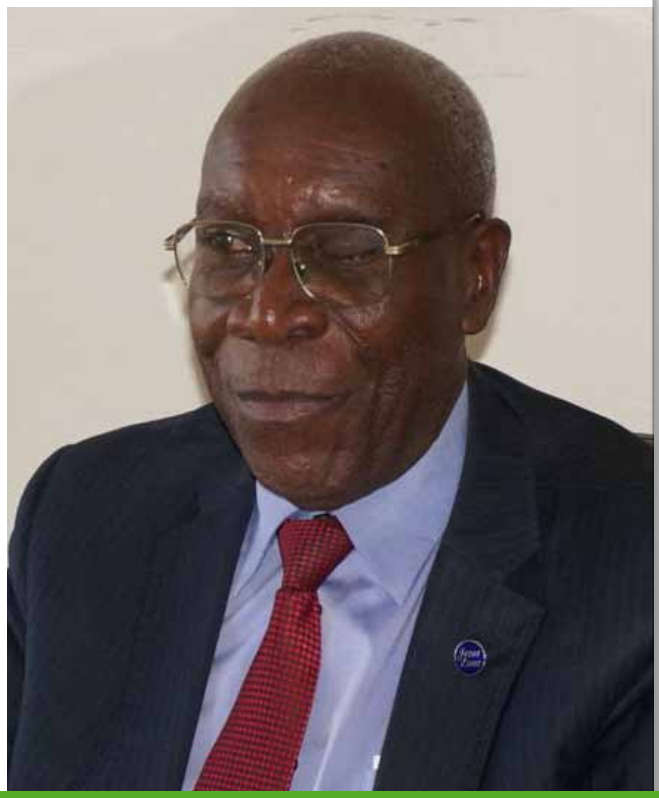

Zerubabel Mijumbi Nyiira

- State Minister for Agriculture and elected Member of Parliament (Uganda)
- Founding Executive Secretary of the National Council for Science and Technology
- Presidential Awardee for Outstanding Leadership in Agricultural Sciences

“GM technology is not the preserve of the western world and so [our people] must come to understand that we are not passive recipients of technology but that we are, indeed, capable of defining our own biotechnology research and development agenda to solve uniquely Ugandan and African problems.”

Biotechnology is New Knowledge to Advance and not Retrogress Humanity

Gilbert Gumisiriza

As the founding executive secretary of the Uganda National Council for Science and Technology, Prof. Zerubabel Mijumbi Nyiira had the privilege of having an early opportunity to recognize and appreciate the potential of modern biotechnology toward contributing to the country's priority sectors — health, agriculture, manufacturing industry, and environment. He championed the integration of modern biotechnology into the country's research agenda and led efforts to establish mechanisms for the safe application of biotechnology in the early 1990s.

Currently the state minister for agriculture and also an elected member of parliament for Buruli County, Masindi District, Prof. Nyiira still holds the deep conviction now, as then, that modern biotechnology bears great potential for revolutionizing agriculture. In a confident tone, he asserts, "There is no doubt that modern biotechnology represents the future as far as plant breeding is concerned; it is part of the knowledge continuum in the field of crop genetic improvement."

Responding to New Knowledge

He points out that, throughout history, agricultural enterprise has been characterized by progress. "From the work of Gregor Mendel in the 19th century — which laid the foundation for modern classical breeding, to the unravelling of DNA in the 20th century — that ushered in the era of genetic engineering, agriculture has always progressed in tandem with advances in our understanding of biology. That is to be expected because new knowledge should take us forward rather than backward!"

To secure a comfortable place in an increasingly knowledge-based global economy, Prof. Nyiira emphasizes the importance of embracing opportunities that bring new knowledge to shape a brighter future for humanity. In stern admonition, he affirms, "we can only shun new knowledge at our own peril," and adds that with the recent advances and convergences in fields such as biotechnology, genomics, and nanotechnology, "we should expect to see new knowledge translated into practical solutions that are brought to bear on some of the most pressing challenges of the time for the betterment of the livelihoods of our people."

Prof. Nyiira's experience spans over four decades in agricultural research, science administration and management, public policy, academia, and political leadership, both locally and internationally. His debut to this long and illustrious career was in November 1968, at the age of 28, when he was appointed head of the Kawanda Agricultural Research Station, making him the first African to hold the position under British colonial rule.

He has subsequently held the positions of director of agricultural research, chief agricultural research officer and head of Uganda's agricultural research before joining the International Service for National Agricultural Research (ISNAR) as senior research fellow; the International Centre of Insect Physiology and Ecology (ICIPE) as senior principal research scientist and director of international cooperation and training; director of the Agro-technology Resource Centre (ARC), and consultant advisor on science economy and international science policy at the UN.

For his outstanding accomplishments, Prof. Nyiira received the 2006 Presidential Award for Outstanding Leadership in Agricultural Sciences, and two national medals in 2013 for Outstanding

Scientist and Outstanding Science and Technology Administrator in Uganda.

As a member of parliament, Prof. Nyiira has been notable for championing an aggressive approach to wealth creation in his constituency through agriculture. He pioneered the establishment of community-based and parish-based seed banks and seedling nurseries with over 3.5 million coffee seedlings from which beneficiaries have planted in excess of 1500 acres of coffee and earned millions of shillings.

Technological Refinement

The science of biotechnology remains generally shrouded in controversy, but Prof. Nyiira notes that biotechnology is broad and we have been exploiting it for millennia, in its most rudimentary forms, through processes such as brewing beer and making yoghurt. Modern biotechnology only represents a technological refinement in the application of knowledge that has been with us for a very long time. He remarked that knowledge has advanced to the level where it is now technically feasible to identify a particular gene determining a beneficial plant characteristic and transferring that beneficial factor into a plant of choice — something that man has been doing for thousands of years, albeit in more rudimentary ways. "Using this new knowledge," he notes, "plant breeders can accelerate the rate of achieving genetic gain in crops with unprecedented pace and precision. This is particularly useful in Africa where most of our staples are difficult to cross-breed due to narrow gene pools."

He believes that one of the biggest challenges regarding modern biotechnology is how to explain this sophisticated science and precision technology to the masses, most of whom still have trouble visualizing the abstract. "In democratizing science and technology, we must take a deliberate and purposive approach to enlighten our people and elevate them to the point where their understanding of science is in the positive sense of what it can do for them," he posits. His conviction is that education, more than anything else, will drive the paradigm shift in how people view modern biotechnologies, such as genetic engineering, as tools for positive transformation. He adds that this process will be gradual and must take into account the peoples' cultural sensibilities and contextual realities. "It must build upon the indigenous knowledge and cast it into a modern perspective that can be better appreciated over time. That is the hope and vision that we must build."

Prof. Nyiira, however, cautions that biotechnology and genetically modified (GM) crops in particular should not be viewed in isolation but in the context of broadening the options available to farmers to address a wide range of agricultural challenges. GM crops would work best as only one part in an array of different but well-integrated enabling technologies available to farmers in different situations.

> **"If you want to call the tune, you must be ready to pay the piper; we ought to be able to define our own priorities and engage with new technologies on our terms rather than being influenced from outside."**

On the public controversy and apparent confusion surrounding agricultural biotechnologies, he says, "Unfortunately, our people have been manipulated and misinformed by anti-science activists and have been led to believe that nothing good can come out of biotechnology. This is shortchanging the many people who need the technology and disarming the fight against poverty and development."

He goes on to explain that there is nothing inherently bad about any particular technology — including biotechnology — beyond the context in which it is applied and it is therefore unfortunate that the dialogue on GM technology has been very polarized and driven by fear and myths rather than

by reason and facts. He stresses that, "We must not forget that every new technology has concerns and adoption does not imply zero risk. If we want to be assured of absolute safety in life, we would be doing nothing — including riding in motor vehicles or walking the streets. The important thing is to minimize the risks through improving technology and put in place the necessary safety mechanisms in the way of regulatory systems, good monitoring and evaluation systems, which, in the case of GM technology— is the focus of biosafety."

> **"The more our scientists are exposed, the more they are moved to innovate. At the end of the day, what is important is to remain competitive in an increasingly knowledge-based global economy."**

Develop Own Markets

A common argument against adoption of biotechnologies such as GMOs is that it would result in the loss of European markets. However, Prof. Nyiira views this as simplistic and rather paternalistic. He argues that, with the move toward regional integration, the focus ought to be on developing our own markets as Africa and increasing our bargaining power. "If you want to call the tune, you must be ready to pay the piper; we ought to be able to define our own priorities and engage with new technologies on our terms rather than being influenced from outside." However, in a reassuring tone, he remarks that, "It is better to follow the right direction even if you are behind everybody else."

Prof. Nyiira also dismisses as simplistic the argument that GM technology will make local farmers dependent on multinational corporations. "GM technology is not the preserve of the western world and so [our people] must come to understand that we are not passive recipients of technology but that we are, indeed, capable of defining our own biotechnology research and development agenda to solve uniquely Ugandan and African problems."

He, however, remarks that building this technological independence will be dependent on two key factors: the first is developing our own human and infrastructural capacity in biotechnology by investing heavily in knowledge-generating systems. The second is supporting these knowledge systems through deliberate policy interventions that positively impact on science and technology. He adds that it is also important to establish strategic collaborative linkages globally to leverage comparative advantages, because knowledge is exchangeable and exposure also mentors individuals. He intimates, "The more our scientists are exposed, the more they are moved to innovate. At the end of the day, what is important is to remain competitive in an increasingly knowledge-based global economy."

Guo Sandui

- Scientist, Biotechnology Research Institute, Chinese Academy of Agricultural Sciences (China)
- Recognized as Father of China's insect-resistant cotton
- One of the top 10 meritorious figures in China's seed industry

> **"...biotechnology not only unveils the mystery of life, but also transforms nature and promotes human progress and development."**

Biotechnology Promotes Human Progress and Development

Tian Zhang

In the early 1990s, there was a large outbreak of cotton bollworm in northern China. The consequent decrease in cotton production caused serious economic losses and resulted in cotton shortage across the country in 1992, pushing the textile industry to the brink of collapse. Pesticides that were originally sprayed two or three times during the planting season did not work, even when sprayed more than 20 times, as pests had developed resistance. Farmers in many cotton growing areas were often poisoned when spraying pesticides on cotton, sometimes even with lethal consequences. The soil was greatly contaminated due to excessive use of pesticides, rendering cotton fields untillable. Cotton farmers "turned pale at the mention of pests."

While conducting an investigation in a cotton-growing area one day, Prof. Guo Sandui from the Biotech Research Institute, Chinese Academy of Agricultural Sciences (CAAS), met an old man in his seventies spraying pesticide on cotton, his little grandson with him. The old man, upon learning that he was an expert on insect-resistant cotton, came up to him asking. "Are you here to save us?" Thereupon, the old man became tearful, speechless with a lump in his throat. Upon inquiry, he learned that the old man's son and daughter-in-law both died from poisoning after spraying pesticide on cotton two years ago. At that moment, Guo Sandui felt deeply saddened. As an agricultural researcher, he was really ashamed that he was unable to alleviate the suffering of farmers.

Bt Cotton in China

At the end of 1992, the research team headed by Prof. Guo Sandui synthesized insecticidal protein genes derived from *Bacillus thuringiensis* (Bt) for the first time in China. At that point, there were some people in China who were in favor of importing technologies directly from the United States. As the leader of a major project aimed at developing key technologies for the "development of insect-resistant transgenic cotton" under the National "863" High-tech Program, Prof. Guo Sandui was adamantly opposed to the idea. He said, "The ultimate solution lies in independent innovations in the nation and the establishment of a system for the production of insect-resistant cotton on an industrial scale."

> "China puts great importance to research and application of biotechnology."

In 1994, Prof. Guo Sandui and his research team successfully developed monovalent insect-resistance genes with Chinese intellectual property rights using biotechnology and introduced such genes into cotton to create a new genetically stable insect-resistant variety of cotton. They were able to develop the first transgenic cotton plant in China and provide an excellent germplasm for domestic breeders to cultivate insect-resistant varieties of cotton. Later, he successfully developed a bivalent insect-resistant cotton (*Cry1A/CpTI* double-gene transgenic cotton).

But the Chinese scientist did not stop innovating. His goal was to develop new varieties suitable for different cotton-growing areas of China. He cooperated with entrepreneurs in the Chinese seed industry to bring about industrial-scale production of insect-resistant cotton, increasing production and reducing labor costs. In addition, he sought to promote the development of the cotton industry and related industries such as the textile industry while reducing the use of pesticides to protect

the environment and farmers' health. This goal gave him the motivation to successfully create a new system of molecular breeding techniques that resulted in high yielding, high quality and highly efficient three-line cotton hybrids. In 2005, he successfully developed the GM insect-resistant three-line hybrid cotton variety for the first time in the world and used it in production.

> **"The general public must be able to understand, touch, and use biotechnology products."**

Prof. Guo Sandui has made China the second country to have insect-resistant cotton with independent intellectual property rights after the U.S. By 2012, the acreage of domestically developed insect-resistant cotton had accounted for more than 95% of the total area devoted to insect-resistant cotton throughout the country. For this reason, Guo Sandui was honored as the "Father of China's insect-resistant cotton" and "One of the Top 10 Meritorious Figures in China's Seed Industry." The latter was granted by the Ministry of Agriculture, China National Seed Association, and *Farmer's Daily*. A media practitioner first referred to him as 'Father' of the technology and other journalists eventually used this tagline.

Fortunate Events

Giving an account of how he embarked on insect-resistant cotton research and development, Guo Sandui used several "fortunate enough's" to describe his experience: "I was fortunate enough to get admitted into the Department of Biology of Peking University to study biochemistry, since then I have been introduced to the booming field of biotechnology. After graduation, I was fortunate enough to be assigned to the genetics laboratory of the Institute of Microbiology, Chinese Academy of Sciences, which fostered in me a strong interest in using biotechnology to study the genetics of microorganisms such as *Bacillus subtilis* and *Bacillus thuringiensis*. Later, I was fortunate enough to be transferred to the Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, which gave me the desire and the opportunity to use biotechnology to solve major challenges in key technologies in the field of agriculture. I was fortunate enough to be sent to the world-famous Pasteur Institute in France to study the structure and function of insecticidal proteins from *Bacillus thuringiensis*, which gave me the confidence and responsibility to use this tool after returning home. I have been lucky all my life — and to top this, I owe my being able to do something for the country and to convince farmers to choose biotechnology. I believe that biotechnology not only unveils the mystery of life but also transforms nature and promotes human progress and development."

Prof. Guo Sandui has complete confidence in the prospect of using technology to transform China's traditional agriculture, increase farmers' income, and promote industrial development because he sees the great importance that the country attaches to biotechnology: "China puts great importance to research and application of biotechnology. For example, the purpose of the major project aimed at developing technologies for the breeding of new varieties by China is to use biotechnology to cultivate high-yielding, high-quality, disease and insect-resistant, weed-resistant, salinity-tolerant and drought-tolerant new varieties, thereby boosting the capability and competitiveness of China's agricultural sector. So, it has been proven that biotechnology not only has a place in China and even the whole world; it also faces a very bright future."

Assuring Future for Biotech

How can we assure the future of biotechnology? Prof. Guo Sandui says, "We must launch a publicity and promotion campaign for the many biotechnology products in the fields of agriculture, industry, medicine, health, energy, and environmental protection. The general public must be able to understand, touch, and use

biotechnology products. These products must be able to improve the quality of life and the health of consumers. With this, the enormous impact of biotechnology will be demonstrated and its bright future is assured."

As a researcher at the Biotechnology Research Institute, Prof. Guo Sandui has been encouraging the application of biotechnology. He has successfully developed a new insect-resistant and herbicide-tolerant transgenic variety of cotton with Chinese intellectual property rights. He explains, "My career goal remains to be the use of biotechnology to breed more new insect-resistant, disease-resistant, and herbicide-tolerant varieties to provide safer food for the public. I want to continue to breed more drought-tolerant and salinity-tolerant varieties to turn arid and saline wastelands into fertile farmland and oases to improve environmental quality. I am convinced that biotechnology plays a vital role in improving the quality of human life."

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Charity Kawira Mutegi

- East Africa Aflasafe coordinator of the Aflatoxin Policy and Program for East Africa project for the International Institute of Tropical Agriculture (Kenya)
- Norman Borlaug awardee for Field Research and Application

> **We haven't seen or been given credible information to show that there has been a safety concern on genetically engineered food because we depend on knowledge that is generated by scientists.**

Biotechnology, not a Silver Bullet but a Key Tool for Attaining Food Security

Margaret Karembu, Faith Nguthi, and Brigitte Britta

Growing up in Chuka, a small rural town located on the eastern slopes of Mt. Kenya, Dr. Charity Mutegi was, at a very early age, introduced to crop farming as a way of life. She must have lived around typical rural subsistence Kenyan households that shared typical challenges: poor harvest, failed crop, insect- infested and contaminated stored grain, and lack of market for farm produce. No doubt these experiences consciously, perhaps even unconsciously, influenced her future career choices. Years later, Dr. Mutegi, now a widely respected scientist and the holder of the 2013 Norman Borlaug Award for Field Research and Application, endowed by the Rockefeller Foundation, is a strong believer in the use of science in enhancing agriculture and in improving lives.

Early Interest in Science

As a young school girl, Dr. Mutegi was not one to shy away from science. "From the time I started doing science in primary school, I just found it easier and more interesting than the arts." While many young people struggled with the pure sciences (biology, chemistry, physics), in high school, she excelled in these subjects thus setting the stage for a career in science. She went on to obtain a bachelor's degree in food science and post harvest technology, saying of the degree, "I did not consider it an abstract science; it was something that you live on, on a daily basis." She also clearly understood that the quantity and quality of food that people ate directly affected them. "If you give your body little food, then it's going to show... if you give your body poor-quality food, you are going to compromise your well-being... those are food security aspects. Of course, at that time, "food security" did not exist in my vocabulary but that is where my interest was."

It was this simple interest in how food affects human beings that propelled Charity into the field of biotechnology. She now champions the use of bio-control, a pro-environmental and effective way of managing pests by combating them with their natural enemies. She has been involved in efforts of managing aflatoxin, a natural mold that occurs in stored grain. Dr. Mutegi spearheaded efforts to identify the cause of, and solution to, a deadly outbreak of aflatoxicosis in 2004 to 2005, which proved fatal to 125 people in eastern Kenya who consumed contaminated grain. According to the World Food Prize award body, it was her work in this case that won her the coveted Norman Borlaug Award for Field Research and Application. This award is presented to individuals under the age of 40 who emulate the scientific innovation and dedication to food security demonstrated by Nobel Peace Prize Laureate, Dr. Norman Borlaug. "Her diligent research has led to innovative solutions that will avert future outbreaks and safeguard Kenya's staple crop of maize" (World Food Prize, 2013).

Managing Aflatoxin

Dr. Mutegi currently serves as the East Africa Aflasafe coordinator of the Aflatoxin Policy and Program for East Africa (APPEAR) project for the International Institute of Tropical Agriculture (IITA). She is leading further research into developing a product that can be used to manage aflatoxin at the pre-harvest stage. The project has developed a microbial pesticide "Aflasafe KE01", which is currently undergoing registration through the Pest Control Products Board of Kenya. Once in use, the pesticide will offer a natural, environmentally safe, and affordable way to smallholder farmers — many like those in her home area of Chuka — to protect their maize crop from aflatoxin contamination and exposure.

Dr. Mutegi believes that the current state of food insecurity in the world warrants the use of biotechnology in efforts to provide safe, sufficient,

and nutritious food to the global citizenry. In 1961, the world population was about 3.5 billion people and we were feeding that by cultivating about 1.4 billion hectares of land. Fifty years down the line, in 2011, that population had doubled, and we have only increased the cultivated land by 12%. She notes that challenges, including the unavailability of adequate land for cultivation, coupled with a strong reliance on rainfed agriculture and the presence of heavily degraded soils, will not allow countries in sub-Saharan Africa to continue relying on traditional methods of agriculture.

> **Genetic modification (GM) is one of the tools in a basket of many being used to address the issue of food insecurity.**

Of the more popular and to many, controversial form of biotechnology, genetic modification (GM), Dr. Mutegi says that it is "one of the tools in a basket of many" being used to address the issue of food insecurity. However, she does point out that, although a useful tool, GM is "not the proverbial silver bullet," a failsafe solution to the problem. Like all forms of technology, it does have its challenges, most certainly, the ever present concern about the safety of GM foods. But is the fear justifiable? Dr. Mutegi believes it is not. She points out that GM foods have been in existence for nearly 20 years now, yet "... we haven't seen or been given credible information to show that there has been a safety concern on genetically engineered food because we depend on knowledge that is generated by scientists." She also notes that GM foods, just like any other foods, undergo the same rigorous safety checks, based on set standards and through well founded protocols across the globe. She believes that the general public is misinformed about GM technology and its application and wishes that "the voices of experts were as loud as those of the antagonists." And, on the issue that GM crops cause cancer, she says, "I prefer to rely on fool-proof evidence that GM foods cause cancer; personally, I have not come across such proof."

As efforts toward sharing knowledge on biotechnology are heightened, it does seem like the right time for countries such as Kenya to fully understand and harness GM technology. After endorsing the National Biotechnology Policy in 2006, supporting the enactment of the National Biosafety Act in 2009, and helping create institutions such as the National Biosafety Authority, Dr. Mutegi believes that Kenya now has the necessary mechanisms to deal with issues of "research, containment, and commercialization" of GM crops. In addition, she is certain that institutions like the Kenya Agricultural and Livestock Research Organization and local universities can provide the infrastructure as well as the capacity to undertake research and offer advice on GM technology.

Advice to Public

Her advice to the general public, those living in fear of GM technology or in blissful ignorance, is to question their sources of information. "I have absolutely no problem about anybody making a decision to, or not, use GM commodities from an informed perspective... You and I must be willing to question the motive and the source; we must be willing to authenticate that information."

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Claude M. Fauquet

- Director of the Global Cassava Partnership for the 21st Century – GCP21
- Awardee of the Order of Academic Palms (France)

> **We will have to feed more people in better ways by 2050, while facing global climatic changes. To achieve this goal, all technologies, including biotech, will be required. If we do not succeed, the world will have to face tremendous instability...**

Improved Cassava through Biotechnology

Ian Mari E. Reano

"There is an obvious place and need for biotechnology in the world to feed the global population by 2050. Biotech is safe and technically relatively easy to implement in genotypes that have many acceptable properties by farmers. Biotechnology is ecologically-friendly — we can save chemicals, fertilizer, water, and we can still produce more."

Dr. Claude M. Fauquet, director of the Global Cassava Partnership for the 21st Century (GCP21), is a staunch supporter of biotechnology. He has spent most of his career doing virology and biotechnology research. This story began about three decades ago involving a crop that he dedicated most of his time on: cassava. This is a vital source of food and income for smallholder farmers in Africa and is threatened by several bacterial and viral diseases.

After receiving his doctorate in biochemistry from the University Louis Pasteur in France in 1974, he joined the Office de la Recherche Scientifique et Technique d'Outre-Mer (ORSTOM) in West Africa, later known as the Institute of Research for Development. Here, he worked as a plant virologist for 14 years. In Africa, he worked on different viral diseases that affect food crops, vegetables, and industrial crops.

Work on Cassava

While in ORSTOM, Dr. Fauquet obtained one of the first research grants awarded by the European Community and led a project that tackled the epidemiology of cassava mosaic disease (CMD), a viral disease considered the most severe and most important limiting factor in cassava production in sub-Saharan Africa. It causes about 30% yield loss on the African continent. His project paved the way for a comprehensive study of the viral disease. It was around this time when he first worked on biotech. "I got into biotech when I read about Dr. Roger Beachy, a professor at Washington University, St. Louis, and his work demonstrating that virus resistance could be engineered in plants. I was working with CMD in Africa and I immediately had the vision of rendering cassava-preferred landraces resistant to CMD!"

In 1991, Dr. Fauquet and Dr. Beachy founded the International Laboratory for Tropical Agricultural Biotechnology (ILTAB) at The Scripps Research Institute in California with assistance from several supporters, including the Rockefeller Foundation and IRD. ILTAB focused on biotechnology for virus diseases of tomato, cassava, and rice, and was among the first to develop a rice transformation system. They were also responsible for the production of the first transgenic cassava in 1995. Then in 1999, Dr. Fauquet moved ILTAB to the newly created Danforth Plant Science Center in St. Louis, Missouri, where he directed the studies on cassava genetic transformation for virus resistance and molecular plant virology of geminiviruses and ipomoviruses.

Dr. Fauquet continued his support of the cassava crop when he co-founded the Global Cassava Partnership for the 21st Century in 2003, with Dr. Joe Tohme, from the International Center for Tropical Agriculture (CIAT), to fill gaps in research and development on this very important crop for the world. The partnership aims to unlock the potential of cassava to improve the food security and increase income of poor farmers by developing industrial products. He also initiated the Virus Resistance Cassava in Africa project in 2005, wanting to confer resistance to viral diseases in cassava using pathogen-derived RNAi technology and eventually to deliver products to small farmers.

Although majority of his research on biotechnology has been dedicated to cassava, he would also like to see the technology used on other food crops.

Beyond Cash Crops

"The impact of biotech so far has been on cash crops such as cotton, corn and soybean, and it is a pity that it has not been used on major food crops such as rice, cassava, plantain, sorghum, cowpea, and peanut. Fortunately, some dedicated scientists belonging to the public sector, supported by humanitarian foundations and aid agencies, are persevering and I am hopeful that we will see a number of these products being commercialized in the next few years."

In 2007, Dr. Fauquet was knighted with the Order of Academic Palms by the French Ministry of Higher Education and Research and the president of the French Academy of Sciences for his contributions to the development of improved tropical crops, through education and research, and the application of biotechnology for use in agriculture.

> **"I am a strong believer of biotech because it is a fantastic technology, simple, clean, and safe..."**

Dr. Fauquet considers biotechnology as a huge factor in the struggle to feed the global population and that all tools and technologies, present and future, could be harnessed in solving mankind's problems.

"I am a strong believer of biotech because it is a fantastic technology, simple, clean, and safe and because we can change the morphology and physiology of plants to make them drought-tolerant and disease-resistant and, at the same time, have very important and acceptable characteristics in agronomy, productivity, and processing. We will have to feed more people in better ways by 2050, while facing global climatic changes. To achieve this goal, all technologies, including biotech, will be required. If we do not succeed, the world will have to face tremendous instability, unrest, and wars and the ecological equilibrium of our planet will be in jeopardy!"

Hala Eissa

- Senior Scientist at the Agricultural Genetic Engineering Research Institute, Agricultural Research Center (Egypt)

> **Our duty as biotech proponents is to deliver the right information about the safety and benefits of biotech crops to the public, to the media as well as to the decision makers. They should know that biotech crops are as safe as their traditional counterparts.**

Arresting Wheat Problems through Biotechnology

Naglaa Abdallah

"Our dream is to feed all Egyptians from agriculture developed by Egyptians" — this vision is what guides Dr. Hala Eissa, a senior scientist at the Agricultural Genetic Engineering Research Institute (AGERI), Agricultural Research Center, Egypt, in her work.

"I believe that the 21st century is the time for those who believe in science and for those who will have the courage to apply its findings. I am sure that Egypt will be one of the countries that understand the importance and the potential of modern science in solving today's agricultural problems," she says. "I hope to develop our techniques and address biosafety issues in order to commercialize transgenic wheat seeds in the Egyptian market."

Dr. Eissa, who got her PhD from the Department of Genetics, Faculty of Agriculture, Ain-Shams University, was successful in developing a drought-tolerant wheat plant. She believes that Egypt is facing many agricultural problems, including climatic changes due to global warming. "This will affect the availability of water needed for agriculture, as well as cause new plant diseases. Another challenge is the decrease in Egypt's water supply because of plans to erect dams on the Nile. Egypt, therefore, has to adopt new technologies that would help fight hunger," she stresses. Egypt needs to develop plant genotypes that can cope with unfavorable environmental conditions — i.e., drought, heat, and salinity. The country must likewise focus on farmers' health by reducing herbicide and insecticide usage since most of them do not follow safety regulations when they apply these chemicals.

Dr. Eissa and her research group at AGERI have produced drought-tolerant wheat by transferring a gene from barley into wheat. They claimed that their technique reduces the number of irrigations needed from eight to one, and that wheat could be cultivated with rainfall alone in some desert areas. They published their research in the journal *Physiologia Plantarum* in 2005.

Addressing the Drought Problem

Drought stress is a serious problem that limits plant growth and crop productivity worldwide. The research team reported that by transferring a gene called *HVAI1* from barley to wheat, the plants could tolerate low water levels more than the control without leaves wilting. Also, they were taller and had higher yields.

The team evaluated the genetically modified (GM) wheat in the greenhouse and in the field. The field trials were conducted for seven seasons, from 1998 to 2004. The experiments using GM wheat and a local variety were carried out under normal rainfall conditions, without irrigation. In addition, improving plants' ability to cope with water stress might mitigate other environmental stresses such as salinity or high temperature.

Dr. Eissa and her team have also developed rust-resistant wheat. Wheat rust is a devastating fungal disease of wheat worldwide. Transgenic wheat (*Triticum aestivum* L.) that expresses the *chitinase* gene was developed and tested for resistance to fungal infection under greenhouse and field conditions. The resistance to rust was confirmed over 4 consecutive years in the field. Increased yield was recorded for transgenic plants compared with controls, indicating the ability of *chitinase* to confer rust resistance in wheat.

Currently also the vice dean of the College of Biotechnology, Misr University for Science and Technology, Dr. Eissa and her colleagues are paving the way to make their dream come true.

Egypt faces a gap that would reach 45% in wheat consumption because the country's lack of water limits the land area that can be cultivated. They realize that the only solution is to take wheat cultivation outside the Delta, and use genetic engineering to develop several wheat varieties that are tolerant of drought, salt stresses, and rust infection.

> **"I believe that the 21st century is the time for those who believe in science and for those who will have the courage to apply its findings. I am sure that Egypt will be one of the countries that understand the importance and the potential of modern science in solving today's agricultural problems."**

"Our duty as biotech proponents is to deliver the right information about the safety and benefits of biotech crops to the public, to the media, as well as to the decision makers. They should know that biotech crops are as safe as their traditional counterparts. This will contribute to the acceptance of such products by the general public," she notes.

Now, more than ever, "Egypt has a golden chance to benefit from biotechnology, with the new political regime open to new ideas and innovations. A new biosafety law is being established; at the same time, there are a number of biotech crops in the pipeline waiting for approval," Dr. Eissa smiles with optimism.

Vijay Atmaram Ingle

- Farmer leader from Vidarbha, Maharastra, India
- Best Yield awardee, Mahyco and East India Cotton Association
- Best Farmer awardee, East India Cotton Association

> **I shall continue to adopt new technologies as long as I live. Bt cotton is not only my life partner but the thread of my life.**

Cotton is my Partner and Thread of Life

Vijay Atmaram Ingle

The cotton plant is the thread that binds my life. I make money from cotton fiber. It is a source of light as the wick in my lamp is from cotton. Cottonseed oil is used as vegetable oil in cooking many Indian cuisine while domestic animals, particularly ruminants, rely on cottonseed meal, a by-product of oil extracted from seeds. Nothing is left as waste as even the stalk is a source of fuel.

Love Affair with Cotton

It is not surprising, therefore, that I have had a love story with cotton for quite a while. I am a third-generation farmer from Vidarbha, Maharastra, India, having engaged in this profession for 40 years. In addition to cotton, we also plant pigeon pea, fruits and vegetables, mainly papaya and banana. I never got to finish school because our family did not have enough money.

In 1976, I owned a 14-acre land which I inherited from my ancestors. I could only harvest 2.5 quintals of cotton per acre as a traditional grower. Water was a problem in my land so I consulted with experts on how to efficiently use the limited water in my farm. Through irrigation, I was able to increase production and I bought an additional 28 acres of land. Although cotton was 'white gold,' attempts to increase yield through the years proved futile inspite of using drip irrigation and nutrient technology management.

A second revolution was brought by Bt cotton when I agreed to be the first to conduct Mahyco's field trials from 1997 to 1999. There was opposition to its use, but I took the chance. I tried the new cotton hybrids, first on 2 acres and then on 10 acres. I was motivated by what the private seed company told me about potential benefits: higher yield, less bollworm damage, and better response to irrigation and nutrients.

> "Achieving the highest yield per acre, my income (from Bt cotton) tripled in the last 10 years."

Bt Technology Package

I adopted the full package of Bt technology and also improved farm practices based on my experience. Being the first to plant Bt cotton, my farm received wide media publicity, including local newspapers and farm magazines. Support was given by seed company officials and, later, by government officials, university personnel, and an irrigation company. Crop loans were availed of yearly from cooperative banks and organizations.

Achieving the highest yield per acre, my income tripled in the last 10 years. On average, for the last 3 years, our family's farm income is Rs 3,050,000 (US$50,000) per annum. Income from cotton alone is Rs 1,260,000 (US$21,000) by harvesting 28 quintals/acre for 14 acres. When I was planting traditional cotton, I was only getting 2.5 quintals of cotton per acre.

Farmer Vijay Atmaram Ingle shared his experiences during the International Conference on Adoption of Biotech Crops in the Developing World: Case Studies of Farmers in China, India, and the Philippines held on April 2-3, 2013 in Manila, Philippines. His talk in Maharati was translated into English by Dr. Charudatta Mayee, President of the Indian Society for Cotton Improvement in Mumbai.

1 Quintal = 100 kg

> **My social status improved and I became popular. I received several awards for being an outstanding Bt cotton farmer.**

With my higher income, I am able to give my children good education, an opportunity I was not able to get. My daughter has a degree in education while my son studies agricultural biotechnology in the university. With the additional money, I have been able to build a *pucca* or cement house, expand the drip irrigation facilities for my fruit crop garden, and establish a dairy farm with 100 animals. In 2010, I was able to purchase an additional 8 acres of land. My farm is now 14.08 ha, while my brother owns 18.15 ha. Six members of our family work in the farms for 7-8 hours daily and we hire people as needed. To top it all, I am able to pay my loans regularly and I have time to spare for my hobby, writing poetry.

My social status improved and I became popular. I received several awards for being an outstanding Bt cotton farmer. These include Mahyco's highest yield award in 2003, the East India Cotton Association Award for best yield in 2005, and the Best Farmer Award in 2006. The newspaper *Lokmat*, a popular reading fare in Marathi, gave me a certificate of merit for best exhibition in 2012 while *Fertilizer Hemphus* honored me that same year. I received invitations from various organizations to share my story of Bt cotton in India.

Model Village

My village in Chitawaldi became a model for rural development in the Vidarbha region of Maharashtra. Farmers share information on cultivars, fertilizers, spraying, farming costs, irrigation, and market prices. To convince other farmers in the village, we conducted feeding trials during farm demonstrations and had visits by university scientists to disprove toxicity concerns.

Farmers who do not make sincere efforts to grow the crop will not experience higher yields and prosperity. But we appreciate technical guidance from experts and the marketing provisions. Discussion with professionals on Bt cotton production is likewise helpful.

In May 2012, we celebrated the 10th birthday of Bt cotton on a grand scale in the village. I invited top executives from Mahyco and a drip irrigation company to witness a rally attended by 1,000 farmers from my village and surrounding ones. To honor the emergence of this technology which has changed my life, I thought the best way was to celebrate its birth in my farm. I did this with the same affection as I did for my children.

I shall continue to adopt new technologies as long as I live. Bt cotton is not only my life partner but the thread of my life.

Karim Traore

- Bt cotton farmer leader (Burkina Faso)
- Chairman, Union of Burkinabe Cotton Farmers

> I can tell my fellow African cotton growers that this technology is necessary and we must move with the changing times.

GM Cotton is a Social Safety Net in Burkina Faso

Margaret Karembu, Faith Nguthi, and Brigitte Bitta

The history of cotton production in Burkina Faso dates back as far as the 1900s when it was introduced during the years that the country was under French colonial rule. After 1960, when the country gained its independence, cotton production picked up with greater momentum. This was largely as a result of the formation of SOFITEX (Burkinabe Society of Textile Fibers), a company that saw the state's involvement in the production of cotton, in research and extension services as well as in marketing of the crop. During those years, cotton thrived, leading many farmers in the region to regard the crop as their newfound 'white gold'.

More recently, cotton has found its place as one of the cornerstones of Burkina Faso's economy, accounting for 3.5% of the Gross Domestic Product (GDP), and supporting a large percentage of the rural workforce. The World Bank estimates that between 15 to 20 percent of the labor force derives its income directly from cotton. Aptly put, "cotton plays the role of the social safety net in Burkina Faso". [1]

Cotton Growing through Generations

It is possibly for these reasons that cotton farmers in Burkina Faso take their crop very seriously. Take the case of Mr. Karim Traore, a 48-year old cotton farmer from the region of Boucle du Mouhoun. His people have grown cotton for as far back as he can recall. "My forefathers grew it, my father planted it, and I began to accompany my father to the cotton fields when I was 7 years old. At 20, I became a land owner — I had no doubt in my mind what I wanted to do." So much so that he skipped high school education to pursue his interest in cotton farming. And so evident was his passion that, in 1988, members of his local farmers' group based in Dankuy Village, assigned him the responsibility of weighing all the farmers' cotton during harvest. In the years that followed, he was elected to various positions of responsibility in cotton producers' unions and other types of farmers' organizations at country and regional levels.

The risk of having given up his education for cotton production seems to have paid off because Mr. Traore now stands as one of the country's better known cotton farmers. He owns a 95-ha farm, a third of which he uses to grow genetically modified (GM) or Bt cotton. He is also the chairman of the Union of Burkinabè Cotton Farmers. As chairman of that Union, he represents 350,000 farmers. He is therefore well versed with the production of GM cotton and the issues surrounding its adoption.

> **"I believe that Bt cotton is a good seed. The main advantage is that we spray less. With conventional cotton, we sprayed 6 to 8 times thus, polluting the country side, but with the reduction in pesticide spraying of two times only, our health is preserved — after all, one's health is priceless."**

While the greater part of Africa has lagged behind in embracing agricultural biotechnology and in particular GM products, not so for Burkina Faso. In 2003, the National Agricultural Research Institute in collaboration with the seed production company Monsanto, commenced field testing of the biotech cotton seed, Bollgard®II. Bollgard®II is a revolutionary seed that was created by taking two genes from the soil bacteria, *Bacillus thuringiensis*

and inserting them into the cotton plant, resulting in what some consider a 'super cotton crop'.

By the time Burkina Faso began these field tests, cotton farmers had already started to experience effects of overuse of the pesticides they were using to control pests. Because of cotton's vulnerability to pests such as the cotton bollworm, cotton stainers and red spider mites, all of which attack it at various stages of growth, the crop requires intensive pesticide use.

Mr. Traore remembers that "At that time, although cotton was occupying a smaller portion of the farm than it is now, we used a lot of pesticides. The chemical pesticides were very dangerous and we used to close the chicken house all day during spray days. We noticed that reptiles in the field would die after the sprays." He also vividly recalls a year when his cotton crop was severely ravaged by the cotton bollworm, and instead of harvesting between 500 and 700 kg of cotton per ha as expected, he only managed about 100 kg of cotton per ha.

> **"Bt cotton has changed my life. I am able to send all my children to school, meet my medical bills, and allow me to afford better accommodation for me and my family."**

Steady Cotton Production Growth

In 2008, Burkina Faso became the second country in Africa, next to South Africa, to commercialize Bt cotton. Shortly after, Mr. Traore joined the group of pioneer farmers who had quickly developed an interest in the new cotton 'super crop.' He says, "I began cultivating Bt cotton in 2008 and have been growing it for 7 years now. Currently, I have a 95 ha farm, where 30 ha is occupied by cotton." From an initial 8,500 ha planted in 2008, the national hectarage for biotech cotton grown in Burkina Faso has risen steadily. In 2014, Mr. Traore, together with thousands of other risk-averse Burkinabe farmers, planted close to 500,000 hectares of biotech cotton.[2] " Mr. Traore notes that "GM cotton production is experiencing growth every year."

The most obvious advantage of the biotech cotton is a remarkable reduction in pesticide use. Mr. Traore says, "I believe that Bt cotton is a good seed. The main advantage is that we spray less. With conventional cotton, we sprayed 6 to 8 times thus, polluting the country side, but with the reduction in pesticide spraying of two times only, our health is preserved — after all, one's health is priceless." He also cites reduced labor involved in the production of Bt cotton production. With fewer pesticide spraying sessions required, less distance is covered and less time is used to cover the cotton fields.

Economic Gains

But perhaps the greatest benefit to farmers such as Mr. Traore, has been the economic gains gotten from the crop. The yield per hectare of Bt cotton as compared with conventional cotton is very high. Traore explains that "In previous years, the yields from conventional cotton were between 500 and 700 kg per ha. With Bt cotton, I get between 1,800 to 2,000 kg. There was even a time my farm yielded 3 tons (3,000 kg) of Bt cotton per hectare." In one season, Mr. Traore can earn anything from 6 million to 7 million CFA Franc (US$12,000 to US$14,000). After spending an average of 3 million CFA Franc (around US$6,000) on farm inputs, he is left with a profit of a similar amount.

Although some farmers have cited the higher cost of Bt cotton seed compared to conventional cotton as being one of the reasons they are not so keen on the crop, Mr. Traore thinks this is a misconception. He notes that "When you look at the number of pesticide sprays we save on, that cost is what makes Bt cotton seed 5 times more expensive than conventional seed. But when you take the cost of doing the 4 to 5 extra pesticide sprays and then consider that you will not need them, you realize that, in terms of the money spent, the difference between the cost of purchasing Bt cottonseed

against the conventional cotton seed is only 6,000 CFA Franc (US$10)." He believes that this cost is nothing compared to the benefits accrued to one's health, mainly as a result of using less pesticides.

Mr. Traore is certainly not one of the naysayers of biotechnology. He says that, "Bt cotton has changed my life. I am able to send all my children to school, meet my medical bills, and allow me to afford better accommodation for me and my family." He adds, "I can tell my fellow African cotton growers that this technology is necessary and we must move with the changing times. Even though there are laws governing the introduction of biotech crops in some countries and others are waiting for these laws to be ratified, I can, nonetheless, reassure my fellow cotton growers that producing Bt cotton is very beneficial, is much easier, and less tedious to plant compared with conventional cotton."

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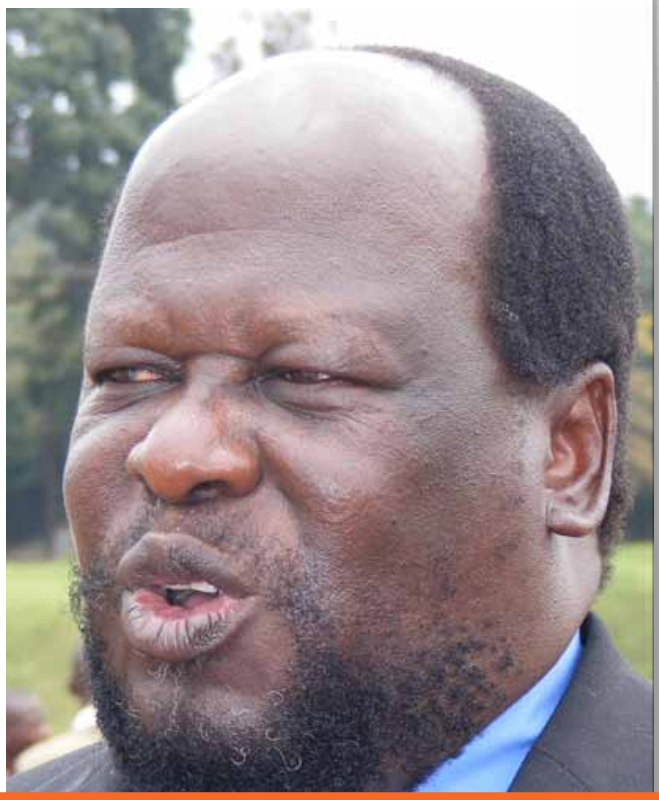
Harnessing Benefits and Potentials



Morris Ogenga-Latigo

- Former Member of Parliament and Vice Chairman of the Forum for Democratic Change Party (Uganda)
- Former Professor of entomology and ecology at Makerere University
- Former Chair of the National Biosafety Committee

> **It is absolutely unfair to expect that technology will make up for institutional inadequacies; it will still require the professional extension services, the right policies and strategic investments. At the end of the day, technology cannot be expected to work like a magic wand!**

Embrace Knowledge; Do not Stifle Progress

Gilbert Gumisiriza

"Modern agri-biotechnologies hold enormous potential for revolutionizing African agriculture toward driving economic transformation, so our governments need to facilitate science and not stifle progress." This stern counsel comes from Professor Morris Ogenga-Latigo, an accomplished statesman and former professor of entomology and ecology at Makerere University, Kampala, Uganda.

Pointing to the fact that Uganda is transitioning from a subsistence economy to an increasingly industrialized one that is likely to render prevalent methods of farming obsolete, he wonders, "Do we want to empower our farmers to remain competitive or to remain stuck in the subsistence trap? How are we supposed to feed a burgeoning population and face up to the emerging effects of global climate change with inefficient and outmoded farming practices? We must take an earnest and critical look at what we want the future to look like for us!"

Notable Voice in Uganda

As a key personality in the local scientific and political echelons, Professor Ogenga-Latigo has been one of the most notable voices for science in the country. In 1996, he was chair of the then nascent National Biosafety Committee (NBC), a technical committee of eminent scientists that represents the cornerstone of regulatory oversight in genetically modified organism (GMO) research. He was instrumental in the development of the national guidelines for GMO research which laid the foundation for a biosafety regulatory system in Uganda. During his tenure, the NBC also supervised the successful conduct of the maiden GMO research projects in the country, including confined field trials of GM cotton and clinical trials of a recombinant DNA candidate vaccine for AIDS, the first of their kind in the world.

In 2001, Professor Ogenga-Latigo forayed into politics and was elected member of parliament for Agago County, Pader District. He served from 2001 to 2011. He was also the vice chairman of the Forum for Democratic Change (FDC) political party and leader of opposition in the 8th Parliament. This impressive political record belies an accomplished academician who has authored more than 100 publications and mentored scores of scientists in Uganda and beyond. During his stint as professor at Makerere, he played a key role in establishing the biotechnology training program under the Faculty of Agriculture. This program was the first capacity-building initiative to provide targeted training in modern biotechnology in the region, produced the first crop of biotech professionals in Uganda.

> **"I understand the science of GM and can see the promise it holds of transforming agricultural productivity. Nevertheless, if there are any plausible risks that science can identify, it is important that we approach these from a scientific premise rather than an emotive one."**

Professor Ogenga-Latigo believes that the current controversy on genetically modified organisms (GMO) is overly simplistic and largely misses the point. He laments that the discussion on GM technology has deteriorated into an ideological impasse that has derailed objective and nuanced

discussion about opportunities presented by scientific advances. "Farmers' ability to access new and improved technologies like GM crops is *sine qua non* to improving agricultural productivity yet skeptics are clinging to ideology and ignoring the potential of GM crops." He argues that this has largely served to stifle rather than facilitate progress and that the unfortunate causalities are the resource-poor farmers who stand to benefit the most from advances in agricultural technology.

Shift in GMO Debate

It is time to shift the GMO discussion to a more rational and constructive direction by eschewing ideology and focusing, as much as possible, on what is best for people to become food-secure and self-sufficient. Such a constructive debate has to acknowledge the opportunities offered by GM technologies and address reasonable concerns that the current controversy does not.

"As a scientist with a breadth of experience in biotechnology and biosafety, I understand the science of GM and can see the promise it holds of transforming agricultural productivity. Nevertheless, if there are any plausible risks that science can identify, it is important that we approach these from a scientific premise rather than an emotive one," says Professor Ogenga-Latigo, whose postdoctoral research involved pioneering work on the use of DNA biotyping for the molecular classification aphids.

As a seasoned lawmaker, Professor Ogenga-Latigo is intimately familiar with the nature of discussions around the regulation of GMOs and a proposed biotechnology and biosafety bill currently before the Ugandan Parliament. He notes that, while it is unfortunate that the debate has proven so divisive in the public, it would be even more unfortunate if policy makers ignore scientific consensus and allow emotions and ideology to triumph.

He decries the irresponsible scaremongering by the anti-science activists that has served to perpetuate fear and misinformation about biotechnology, noting that "the anti-GM skeptics will not be swayed by science because they have embraced an ideology that is fundamentally at odds with that science." Most of the arguments against biotechnology are sentimental and unjustified attacks on technology that have nothing to do with science, such as the claim that we will lose the market for our exports. "If we grow GM banana and export non-GM sugarcane, how could we possibly lose access to foreign markets?," ponders Professor Ogenga-Latigo.

> **"Farmers' ability to access new and improved technologies like GM crops is *sine qua non* to improving agricultural productivity yet skeptics are clinging to ideology and ignoring the potential of GM crops."**

He concedes that the highly technical nature of the science of modern biotechnology has not been adequately simplified to the public, leading to widespread myths and public aversion. "As soon as people start talking about genetic engineering in Uganda, there is a cultural blank because there is nothing to relate to in the everyday experiences of the layman. This gives fertile ground for the propagation of all sorts of falsehoods and misconceptions."

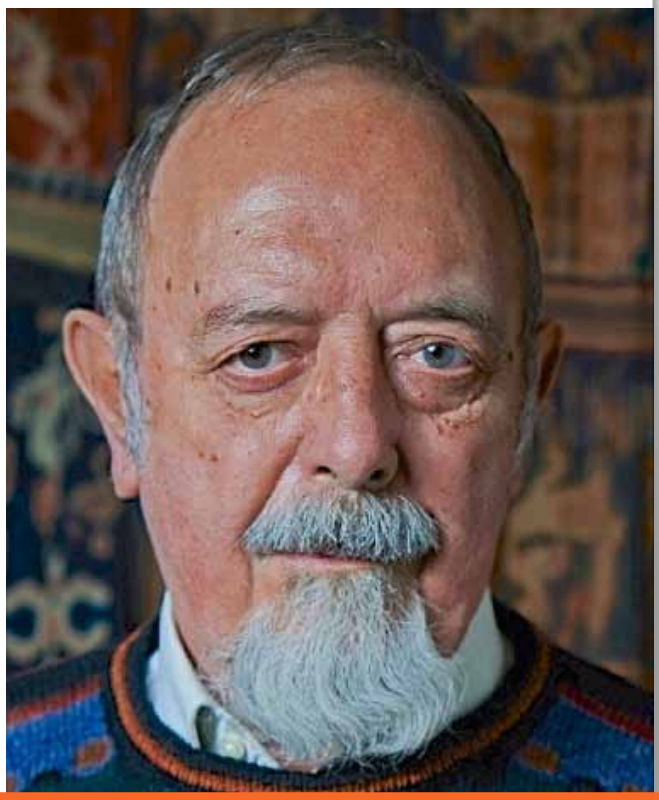
He is, however, optimistic that, as people begin to understand in simplified ways, that DNA is a universal medium for genetic information and that genes are analogous to computer programs that can be exploited to achieve desired outcomes, perhaps they will appreciate the fact that GM technology is just a tool that extends our capabilities to address emerging challenges such as climate change, pests, and diseases.

Option for Innovation

He hastens to caution that GM technology, like all technologies, is not a panacea to all agricultural

challenges that beset the resource-poor farmers in Uganda, but rather a complementary tool in the ballpark of options for innovation toward a more sustainable world. "It is absolutely unfair to expect that technology will make up for institutional inadequacies; it will still require the professional extension services, the right policies and strategic investments. At the end of the day, technology cannot be expected to work like a magic wand!"

Above all, Professor Ogenga-Latigo, emphasizes the need for more voices speaking up for science and reason, especially within the political leadership; we must sensitize our leaders and put science in a language that our politicians and the public understand.



Ingo Potrykus

- Scientist and co-inventor of Golden Rice
- One of Top Living Contributors to Biotechnology by the peers of *Scientist* (2005)
- Most Influential Scientist (1995-2005) by the peers of *Nature Biotechnology*

> **As soon as GM technology will be freed from automatic, excessive, precautionary regulation, hundreds of public sector projects for the public good would win the minds and hearts of the citizens around the world and this will end the unprecedented hysteria on GMOs.**

Use of Biotechnology is a Social Responsibility

Rhodora R. Aldemita

Known as the co-inventor of Golden Rice (GR), a genetically modified rice that contains high beta carotene, Ingo Potrykus was first a biotechnologist and now an advocate of the technology.

His interest in biotechnology was spurred by the phenomenon of totipotency of plant cells — the ability of plant cells to regenerate into whole plants. Dr. Potrykus' fascination was nurtured during his graduate studies at the Max-Planck Institute for Plant Breeding Research in Koln, Germany, in the 1960s.

"Back then, I was dreaming of creating nearly unlimited genetic variation via genetic modifications of those cells and explored somatic hybridization, asymmetric hybridization, transfer of organelles, and transfer of isolated genes," Dr. Potrykus says.

Indeed, the pioneering years of biotechnology in the early 1970s, after the Green Revolution, was the period when scientists were exploring the possible use of recombinant DNA to speed up development of new varieties. The successes in conventional breeding of new varieties of staple crops were instrumental in attaining food security in developing countries during those times.

However, an anticipated increase in population needs more drastic agricultural technologies. Dr. Potrykus, one of the pioneering scientists on biotechnology, was already thinking "big" as he was contemplating on "complementing traditional plant breeding technology with the potential of large populations of totipotent somatic cells to create novel variations in crops."

For Dr. Potrykus, his "academic career was more influenced by the attitude of an engineer (with the desire to solve concrete problems) instead of a scientist (working towards scientific novelty). Contributing to and making use of the progress in tissue culture, molecular biology and genetics, and genetic engineering technology was the most natural way for scientists to follow his social responsibility and contribute to humanity."

With this motivation, Dr. Potrykus' work focused on research that would contribute to food security in developing countries. These include studies on the development and application of genetic engineering technology for "food security" crops such as rice, wheat, sorghum, and cassava; for disease and pest resistance; improved quality and yield; and efficient use of natural resources and improved biosafety.

Golden Rice

His most impressive work was the development of GR with co-inventor Prof. Dr. Peter Beyer of Albert-Ludwigs University in Freiburg, Germany. GR, a genetically modified rice with enhanced beta carotene content, was developed in his laboratory at the Swiss Federal Institute of Technology, Zurich in the late 1990s. The team developed GR by genetically engineering rice cells to contain genes coding for phytoene synthase (*psy* gene) from daffodil and phytoene desaturase (*crtI*) from *Erwinia carotovora*, the two important enzymes that allow the production of beta carotene in the rice endosperm. The prototype Golden Rice in Taipei 309 (japonica subspecies) background developed by the team was able to produce 1.2-1.8 µg/g beta carotene in the grain, using a constitutive promoter (Ye et al. 2000). This research is one of the pioneering works on metabolic engineering and proof that rice has the capacity to produce beta carotene when given the

necessary genetic machinery. This research work was the cover and featured research article of *Time* magazine in July 2000.

To improve beta carotene content, the two genes *psy* and *cryt*I were placed after an endosperm- specific promoter *gt1* in a Cocodrie background, which produced around 8 µg/g beta carotene (Golden Rice Project website), hence the development of GR 1. A few more years of experimenting various sources of *psy* genes identified corn *psy* to be the most appropriate and the use of another endosperm-specific promoter (*GluI1*). Designated GR 2, some transgenic lines were able to produce up to 37 µg/g beta carotene in the endosperm (Paine et al. 2005).

Distribution and utilization of GR 1 and GR 2 in developing countries affected by Vitamin A deficiency was monitored by the Humanitarian Board composed of scientists and socio-economists and chaired by Dr. Potrykus.

International Recognition

Dr. Potrykus' scientific career spans more than three decades with about 340 publications in peer-reviewed journals and 30 patents. He has garnered international recognition from professional societies; honorary doctorates in two European universities; elected member of science academies of Europe, the Pontifical Academy, Hungary, and Switzerland; and earned prestigious titles such as the "Top Living Contributors to Biotechnology" by the peers of the journal *Scientist* in 2005 and "The Most Influential Scientist" for the decade 1995-2005 by the peers of the journal *Nature Biotechnology* in 2006.

Looking forward, he thinks that the future of biotechnology in many countries and in the world will depend on whether 'reason' and 'logic' can win the minds of the people. Speaking in the midst of countries critical of biotechnology, he opines that "farmers, media and the whole citizenry should understand that "integrated" not "organic" farming and food production is the most sensible way for both food production and protection of the environment. Large-scale intensive farming is essential for survival of the majority of the world population." He also observed that in the EU, "the mind is set on a romantic view of medieval farming practices, and in this mental environment, biotechnology is seen as the enemy and not as the friend."

He is also of the impression that "the 'European March of Unreason' is colonizing effectively, even those countries which do not have problems with the acceptance of plant biotechnology."

> **"I believe in science, in the social responsibility of scientists, and in the use of progress in science for humanity. It has been established beyond any reasonable doubt that plant biotechnology does not carry any technology-inherent risk."**

Dr. Potrykus, however, is optimistic that, with the many scientific documentation prepared annually by ISAAA and similar agencies indicating increasing adoption and positive impact of biotech crops, many countries will get to accept the technology and reap its immense benefits. And that the targeted benefits for agbiotech industry and farmers in the West are very welcome 'spin-off' benefits from private sector developments for farmers in developing countries.

Public Sector Contribution

Most of the deregulated products on the market so far were developed by a few private agbiotech companies, with almost zero contribution from the public sector. Dr. Potrykus is of the opinion that "this is because of political reasons: an anti-GMO war of eco-ideologists and anti-science populists, and regulation which does not prevent harm to the consumer or the environment, but instead prevents the use of the technology by public institutions for public good."

Dr. Potrykus is primarily interested in the use of biotechnology to contribute to food security, especially for nutrition security in developing countries. "The development of GR," he says, "is an illustration of both the potential and challenges. There is the potential for provitamin A in genetically improved rice endosperm to save millions from blindness and death. And the fact is that the technology is ready since 1999, and will not be deployed — if at all — before 2018, with nearly 20 years of delay because of regulation. There are many projects in the pipeline with potential for nutrition and food security, at or close to proof-of-concept, which will suffer at least the same delay, and if not, they are blocked completely because of shortage of funding."

Regulatory Hurdles

The challenge therefore in this delay and slow progress is regulation. And according to Dr. Potrykus, there is scientific consensus that GMO-specific regulation has no justification and does not make any sense at all. He adds, "if regulation is meant to prevent harm, it must focus on products, not on the technology applied to produce that product." He is hopeful though that, "as soon as GM technology will be freed from automatic, excessive, precautionary regulation, hundreds of public sector projects for the public good would win the minds and hearts of the citizens around the world and this will end the unprecedented hysteria on GMOs."

Social Responsibility

Finally, Dr. Potrykus expressed his belief and social responsibility in the following lines.

"I am not a specific believer of biotech. I believe in science, in the social responsibility of scientists, and in the use of progress in science for humanity. It has been established beyond any reasonable doubt that plant biotechnology does not carry any technology-inherent risk. It is a fact that the technology has the safest track record compared with any other technology in history. There is not a single documented case of harm since its use! It is, therefore, insane not to use it efficiently and prudently. It is immoral to prevent its use for public good. And it is criminal to prevent it from contributing to food- and nutrition security."

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Gregory Conko

- Executive Director of Competitive Enterprise Institute (USA)
- Co-author, *The Frankenfood Myth: How Protest and Politics Threaten the Biotech Revolution*

> **“And because it will be important to produce more food in coming decades while lightening agriculture’s environmental footprint, biotechnology will be one of the tools farmers and plant breeders can use to promote long-term food security and environmental stewardship.”**

Advocating for More Rational Biotech Regulation

Mariechel J. Navarro

The book *The Frankenfood Myth: How Protest and Politics Threaten the Biotech Revolution* was named by Barron's as one of the 25 best books of 2004. In the foreword, Nobel Peace Prize winner Norman Borlaug said that Henry Miller and Gregory Conko had written a "brilliant account of the way self-interest, bad science, and excessive government regulation have profoundly compromised the potential of the new biotechnology." The political process, the book points out, prevents enormous potential benefits to accrue to consumers.

Mr. Gregory Conko is executive director of Competitive Enterprise Institute, a non-profit public policy organization based in Washington, D.C. His work focuses on the regulation of food and pharmaceuticals to ensure that regulatory policy is based on sound science and is no more restrictive than necessary to protect human health and the environment.

Reading on the Literature

In Mr. Conko's work, he found that many regulatory policies that restrict choice and innovation are based on scientifically unjustified concerns about new products and technologies. "It was in that context that I first took an interest in agricultural applications of biotechnology in the mid-1990s, when the first genetically engineered crops were being introduced for commercial-scale cultivation in the United States. I knew that biotechnology had been used with great success in medical technology, so I was immediately interested in learning whether the allegations of health and environmental risk levied against biotech crops were true. I began to read as much of the scientific literature on the testing of biotech crops as possible. And I talked to dozens of scientists and plant breeders about the process of genetically engineering plants and how the risks compared to those associated with classical breeding."

Mr. Conko discovered that some of the criticisms of plant genetic engineering were valid, but that identical risks were also present in conventional breeding. He saw that many of the criticisms were simply unwarranted. "I also found the innovative nature of the field to be fascinating and was convinced that the technology had much to offer farmers, consumers, and the environment. And I was alarmed to find that the regulatory restrictions breeders faced when testing and commercializing biotech applications were quite strict and that they were impeding the development of many promising crop and livestock products. Armed with that knowledge, I thought it was important to begin advocating on behalf of more rational biotech regulation."

As a regulatory policy expert and legal scholar, Mr. Conko's primary contributions to the biotechnology debate have been in three areas: helping scientists, agronomists, and farmers better understand the legal and regulatory systems that affect biotech research, development, and commercialization; advocating on behalf of more rational, science-based regulatory policy; and helping agriculture experts become more effective advocates.

> **"I'd like to think that our efforts are responsible for raising awareness of biotechnology's benefits and debunking myths spread by its critics."**

International Collaboration

"Over the years, I've collaborated with a broad range of scientists and agronomists from North and South America, Europe, Africa, and Asia on writing and doing research projects, explaining to them the ins and outs of regulatory policy and how legal and regulatory barriers impact their work, both directly and indirectly. I have, in turn, learned a considerable amount from them about the science of biotechnology and real-world agricultural practices. And together, we have become more effective in communicating the benefits of biotechnology to consumers, as well as governments and their constituents, and better able to address their concerns," Mr. Conko explains. "I'd like to think that our efforts are responsible for raising awareness of biotechnology's benefits and debunking myths spread by its critics."

Benefits for Farmers

The legal expert asserts that biotech crops on the market today have shown significant benefits for farmers in a number of countries — from large-scale commercial growers in wealthy industrialized countries to small-scale, resource-poor farmers in less developed countries, and everyone in between.

"Most have also shown important environmental benefits, such as reduced insecticide spraying, a shift to more environment-friendly herbicides, reduced soil erosion, and lower motor fuel use and engine emissions. At the same time, no environmental harms or human health risks have been identified nor is there any scientific reason to expect that they would. In short, even the relatively limited range of biotech crop traits now available have been all gain and no pain. And because it will be important to produce more food in coming decades while lightening agriculture's environmental footprint, biotechnology will be one of the tools farmers and plant breeders can use to promote long-term food security and environmental stewardship."

A *magna cum laude* from the George Mason University School of Law, Mr. Conko explains that the current biggest benefits from biotech crop adoption accrue to growers. "In wealthy countries, where insects and weeds in conventional farming are managed well with agricultural chemicals, biotech crops reduce the cost of crop production and increase profitability. In less developed countries, insect-resistant biotech crops have not only increased profitability but also increased yields and, in some circumstances, have helped to protect against catastrophic losses from insect predation. So, the benefits of biotech crops have been greatest for poor farmers."

"But the environmental benefits of reduced insecticide spraying, improved soil management, and higher yields should not be underestimated," says Mr. Conko. "Topsoil and ag chemical runoff from farms, for example, are among the worst pollution problems in wealthy industrialized countries, affecting lakes, streams, rivers and other waterways. By accelerating the on-going shift toward no-till and low-till farming, biotech herbicide-tolerant crops have substantially reduced this runoff problem. And, especially in less developed countries, the substitution of biotech insect-resistant crops for insecticide spraying has even resulted in improved farm worker health."

> **"Biotechnology is simply a breeding tool, like many others, which gives humans the ability to add, remove, or amplify specific traits to a plant, animal, or microorganism."**

Mr. Conko forwards the thought that most consumers have yet to notice these important benefits, noting that environmental improvements delivered by biotech crops help everyone. "To be sure, lower production costs and higher yields have undoubtedly also had positive impacts on the price of food in the marketplace. And if regulatory

impediments do not prevent the next generation of biotech crops from reaching the market, consumers will soon notice the availability of foods with improved nutritional value and other direct consumer benefits."

Excessive Government Regulation

"Consumer resistance remains an impediment to broader adoption in some countries, and this affects growers in countries that rely on exporting to markets where consumer resistance remains strong. But the biggest current hurdle to broader biotech crop adoption remains excessive government regulation of biotech crops and foods derived from them. Biotech crop adoption will continue, albeit slowly." Mr. Conko adds that as a new generation of biotech traits begins to deliver perceptible consumer benefits — such as nutritionally enhanced foods — he anticipates consumer acceptance growing more robust over time.

Although public acceptance of biotech foods is generally thought to be the biggest challenge in the biotech world, it is actually the hurdles erected by scientifically unjustified regulation. Mr. Conko elaborates that government restrictions have kept biotech crops off the market entirely in some countries. And, even in a country such as the US, which has approved more biotech traits than any other, the financial cost and time delays associated with seeking and securing regulatory approval make the use of genetic engineering economically impractical for all but very high-value commodity crops and have concentrated commercial development in the hands of a few large multinational corporations.

The regulatory cost alone of bringing a new biotech crop variety to market in a country like the United States can total millions of dollars, says Mr. Conko. He cites Redenbaugh and McHugen (2004), who state that these regulatory costs typically exceed the entire market value of small horticulture crops, such as beans, peas, and lettuce.

Prohibitive Field Testing

Breeders of non-biotech crops, Mr. Conko explains, will often test thousands of unique genetic variants in the field each year in order to select a single cultivar for commercialization. "But regulators treat each transformation event of a biotech crop to be a unique regulated product. So, a single gene inserted into a dozen plants of the identical cultivar results, not in 12 copies of one regulated product, but one copy each of 12 different regulated products. Thus, the normal field-testing process is made prohibitively expensive for biotech crops, and even well-financed breeders must select only a handful of transgenic events for field testing. When small start-up firms, non-profit research centers, and public-sector breeders can afford to field-trial a biotech crop at all, they are generally limited to testing just one or two transformation events, thereby inhibiting the R&D process."

> **"And if regulatory impediments do not prevent the next generation of biotech crops from reaching the market, consumers will soon notice the availability of foods with improved nutritional value and other direct consumer benefits."**

"But many of the most interesting and potentially beneficial biotech crop traits have been or are being developed in public sector and non-profit research institutions. These include crops with added nutritional value, crops modified to address abiotic environmental stresses or to grow well in poor soils common in the tropics, and varieties of crop species grown primarily as staples in less developed countries such as cassava, millet, and sweet potato. Merely testing these crop varieties in field trials is often prohibitively expensive. And, even when one or more varieties performs well in field trials, the cost and political hurdles inherent in seeking full commercial approval too often keep

these promising crops out of the hands of the farmers and consumers who could use them most," Mr. Conko notes.

Powerful Technology

Despite the political barriers to commercialization, however, biotechnology needs to be at the radar screen of innovation. Mr. Conko stresses that "biotechnology is simply a breeding tool, like many others, which gives humans the ability to add, remove, or amplify specific traits to a plant, animal, or microorganism. But unlike other breeding methods, biotechnology gives breeders the ability to move single, well-characterized genes rather than rely on the hit-or-miss approaches of classical breeding in which many, typically uncharacterized genes must be moved or altered at the same time. This more precise nature gives breeders a far greater ability to predict the genotype and phenotype that will result from any given breeding experiment.

Biotechnology is therefore far more powerful than other breeding methods. But it is that very power that makes biotechnology safer than classical breeding. Biotechnology cannot solve most of agriculture's problems. However, it has already addressed many once-intractable problems, and it has the potential to address many, many more."

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Pamela Ronald

- Professor at the Department of Plant Pathology and the Genome Center at the University of California, Davis and faculty director of the UC Davis Institute for Food and Agricultural Literacy (USA)
- Louis Malassis International Scientific Prize awardee for agriculture and food
- Co-author, *Tomorrow's Table: Organic Farming, Genetics, and the Future of Food*

> **"To maximize the benefit of GE plants, they would best be integrated into an organic farming system. In this way, there is a complementation of practices and technology — the organic practices protect the environment and the GE technology helps reduce crop losses to disease or environmental stress."**

Setting the Table for Tomorrow

Kristine Grace N. Tome

Geneticist Pamela Ronald provides balanced information on genetic engineering. In fact, she hopes to see that future tabletops will have food grown in an ecologically-based manner and advocates for such a future.

Dr. Ronald is a professor at the Department of Plant Pathology and the Genome Center at the University of California, Davis. She is also the faculty director of the UC Davis Institute for Food and Agricultural Literacy.

Dr. Ronald's laboratory is known for the isolation of the rice *XA21* immune receptor and working with colleagues to discover the rice *Sub1A* submergence tolerance transcription factor, which has been used by breeders to develop flood tolerant rice varieties. Because of these breakthroughs, Dr. Ronald and her colleagues received the USDA 2008 National Research Initiative Discovery Award. She also received other prestigious awards such as a Guggenheim Fellowship, the Fulbright-Tocqueville Distinguished Chair, and the National Association of Science Writers in Society Journalism Award. She is an elected fellow of the American Association for the Advancement of Science (AAAS). In 2012, Dr. Ronald received the Louis Malassis International Scientific Prize for Agriculture and Food and Tech Award 2012 for innovative use of technology to benefit humanity.

Aside from her scientific involvement, Dr. Ronald is also active in public engagement. She co-founded Biology Fortified, Inc., a non-profit organization focused on providing factual information and fostering dialogues on issues in biology, especially on plant genetics and agricultural biotechnology. She actively supports science through articles, some of which were published in *The New York Times*, *The Economist*, and *Boston Globe*. In 2008, Dr. Ronald and her husband, Raoul Adamchak, an organic farmer, released the book *Tomorrow's Table: Organic Farming, Genetics, and the Future of Food*.

Impact of Genetic Research

In her interview with *Beacon Reader*, Dr. Ronald narrated the impact of her genetic research to farmers. "Every year, millions of small rice farmers lose their entire crops to flooding. Even though rice plants grow in water, most varieties will die after 3 days of being submerged. Breeders knew of an ancient variety that could withstand 2 weeks of submergence. But every time they tried to introduce this flood tolerance trait using conventional breeding, other genes would be introduced as well, resulting in varieties that the farmers rejected because the seed did not adapt well to their farming practices."

"Together with my colleagues, David Mackill and Kenong Xu, we isolated a gene in the ancient variety, called *SUB1*, that conferred the flood tolerance trait. Then, using that genetic information and a technique called marker-assisted breeding, breeders at the International Rice Research Institute (IRRI) were able to introduce the *SUB1* gene precisely into varieties preferred by farmers without destroying the other important plant characteristics," she said.

Since then, IRRI has developed several flood-tolerant rice varieties that have been rapidly adopted by farmers. Their yields increased by 300% more than what they used to get in planting conventional rice varieties following a flood. Thus, Dr. Ronald stresses that, "For 70 million people who live on less than US$1/day, these types of advances are crucial to food security."

Aside from her own research, she also discussed the impact of other biotech applications in agriculture. "Genetic techniques, such as introducing a bacterial gene into a crop, have helped reduce insecticide use. Bt stands for *Bacillus thuringiensis*; it's a naturally occurring bacteria that is toxic to specific insect pests that attack corn and cotton. Bt has been used by organic farmers for over 50 years to control insect pests. Geneticists have introduced the same trait into corn, called Bt corn. A recent US Department of Agriculture report noted that farmers have been able to reduce the amount of insecticides sprayed on corn tenfold due to planting of the Bt corn seed. This is a huge positive improvement to the sustainability of our farms. The adoption of herbicide-tolerant crops has enabled farmers to substitute glyphosate (classified as non-toxic by the EPA; less toxic than Bt sprayed by organic farmers) for more toxic and persistent herbicides. Still despite these advances, it is clear that farmers cannot rely on seed alone. As we have seen with herbicide tolerant crops, overreliance on a single herbicide has led to the evolution of resistant weeds. "

> **"I am not a believer in biotech any more than any other breeding technology. I am a believer in enhancing sustainable agriculture and food security for the world's poorest. This will require many technologies and ecologically based farming practices."**

In an article about Dr. Ronald in *The New York Times*, the writer asked a significant question — "But how do you retain that productivity without the negative impact?" The answer to this question is found in their book, *Tomorrow's Table*.

"Is genetic engineering (GE) simply a new tool for farmers that in some cases will be the right one? Although genetic modification by conventional breeding and genetic engineering methods are distinct processes, they ultimately have the same end — to alter and improve the genetic makeup of the plant. Whether GE crops fit into a framework of ecological farming gets back to the first thing I tell my students: Organic farming is about health — health of the soil, the plants and animals, the farmer, the consumer, and the environment. A marriage of farming with biological science has always been an important strand of the organic approach. Plants that have been genetically modified using older methods have given rise to nearly every food we eat. Such crops are resistant to diseases, insects, or nematodes; fit in well with organic production; and it seems to me that there is a role there for the right GE crops as well, " her husband Raoul Adamchak wrote.

Biotech and Organic Farming

"At the same time, I think that much of the potential of GE plants is lost in conventional systems that continue to use pesticides and synthetic fertilizers. To maximize the benefit of GE plants, they would best be integrated into an organic farming system. In this way, there is a complementation of practices and technology — the organic practices protect the environment and the GE technology helps reduce crop losses to disease or environmental stress."

Their book surprised people from the scientific sphere and the organic farming sector. Organic farming and GE are perceived to be two distinctly different worlds. Thus, when individuals encounter the book and discover that a believer of biotechnology and a practitioner of organic farming are actually married, they start to question, "Is it really possible for GE and organic agriculture to move towards the same direction?" Their union is a statement that both fields have the same target: food security and sustainability.

In their book, she explained why she thinks that biotechnology can play an important role in the future of food production. During one season, her husband lost half of his tomato crops due to frost. However, they are fortunate that the loss is not a very dreadful situation for them because they still had food on their table.

According to Dr. Ronald, "As Raoul knows, this of course is not the case for the vast majority of farmers on the Earth, where tolerance for environmental fluctuations such as cold, salt, or submergence can mean a difference between eating or not. Traits such as these are the most difficult to address using standard breeding approaches. In the future, this is where genetic engineering will likely have the most significant human impact."

Complementary Technologies

When asked if she is a believer of biotechnology, Dr. Ronald said, "I am not a believer in biotech any more than any other breeding technology. I am a believer in enhancing sustainable agriculture and food security for the world's poorest. This will require many technologies and ecologically based farming practices."

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Photo credit: John Stumbos, University of California, Davis

Inez Slamet-Loedin

- Senior Scientist and Head of the Genetic Transformation Laboratory at the International Rice Research Institute
- LIPI Young Scientist awardee and National Food Security awardee (Indonesia)

> **We need to continue the discussion and share with the general public, especially the youth, the real nature of biotech products. Scientists have to speak out because, if not, who else will?**

From Fascination to Fulfillment

Mariechel J. Navarro

As a young child, Inez Slamet-Loedin would tag along with her anthropologist-mother who worked months at a time doing research work in a village in Klaten, Java, Indonesia. "I had a touch of early exposure to rural life despite being raised in the city", Inez intimates. "I saw how simple life was and the problems that plagued residents in rural and urban communities. I grew up being influenced by what I saw and felt, and my mother is my living example about compassion for others and caring for our surroundings."

By the time Inez was in middle school, she developed a fascination with nature, being awed by the simplicity and, at the same time, complexity of living things. Eventually, she took a natural science major in high school and was accepted at Bogor Agricultural Institute where she specialized in agronomy. During her undergraduate years, she volunteered to work with the Indonesia Green Foundation where she taught ecology to high school students every Saturday. "I would hike with students along the forest reservation near Ciapus, Bogor and share my amazement about the wonders of plants and their role in the environment," Inez recalls.

Excitement for Science

In 1988, she passed the selection for a World Bank postgraduate scholarship program, initiated by then Minister of Science and Technology B.J. Habibie, for major areas in the new sciences. Inez decided to take plant biotechnology at the University of Nottingham in the United Kingdom. "At that time, biotech was relatively new. I had been fascinated with the genetics of inheritance way back in high school, so the idea of discovering new techniques at the molecular level was something that excited me and was worth pursuing."

After a Rockefeller Foundation postdoctoral stint in Leiden, Netherlands, also brewing was Dr. Slamet-Loedin's desire to work on improving rice so that it can grow in the drought-prone areas in Indonesia. She initiated the rice research group at the *Lembaga Ilmu Pengetahuan Indonesia* (LIPI) or the Indonesian Institute of Sciences where the team worked on drought tolerance and insect resistance. The group expanded from, initially, only herself and three fresh graduates to, currently, more than 25 young scientists holding doctoral, masters, and bachelors degrees.

> **"The challenge is not just to feed billions of people who depend mostly on rice, but ensure that they are getting proper nutrition."**

She spent about 15 years at the Research Centre for Biotechnology, LIPI where she eventually became the head of its molecular biology division. She received the LIPI Young Scientist Award in 2002 and the National Food Security Award for her scientific contributions in the field of biotechnology in 2004. She also became a consultant for an UNEP program for biosafety in ASEAN countries.

Next came an opportunity to become a shuttle scientist between the International Rice Research Institute (IRRI) and LIPI in 2006, where she came to the realization that nutritional concerns had a great impact on the well-being and capacity of women and children. She saw that biotechnology was indeed opening opportunities to address abiotic factors and nutritional issues.

Currently a senior scientist and head of the Genetic Transformation Laboratory at IRRI based in Los Baños, Laguna, Philippines since 2008, Dr. Slamet-Loedin is the lead person in projects on genetically modified (GM) rice. The technology has been used at IRRI to identify useful low phosphorus and drought tolerance genes to allow rice to grow under harsh conditions and potential genes to increase rice yield.

Biofortified Rice

Her team is also developing biofortified rice. According to Dr. Slamet-Loedin, "the challenge is not just to feed billions of people who depend mostly on rice, but ensure that they are getting proper nutrition." She cites the prevalence of "hidden hunger" that affects over two billion people around the world. It is a condition with often no visible warning signs, due to chronic lack of vitamins and minerals from the diet, such as iron, zinc, and vitamin A. Many people in Asia rely heavily on rice for most or their entire calorie needs because they cannot afford or do not have access to a full range of nutritious foods. As a result, hidden hunger has become prevalent in rice-consuming countries.[1]

Iron-rich rice, in particular, has the potential to prevent iron-deficiency anemia that affects more than 1 billion people worldwide. Iron deficiency contributes to increased maternal mortality, stifles children's cognitive and physical development, and reduces people's energy. Zinc deficiency, on the other hand, causes stunting in children, affects cognitive development, and compromises the immune system.

Dr. Slamet-Loedin says the iron content in polished rice of the most commonly consumed rice varieties have very low iron concentrations (only 2 to 3 milligrams per kilogram or parts per million), while mining thousands of rice germplasm have resulted in only a maximum of 5-6 ppm iron content. The recommended minimum iron concentration is 13-14 ppm to supply 30% of a person's daily need. Confined field trials of high iron rice in the Philippines and Colombia have shown that this minimum level can be achieved in popular varieties by adding a rice iron transporter and iron-rich soy genes through genetic modification. As a bonus, this GM rice not only reaches the iron biofortification target but also the zinc biofortification target in polished grain.

Misinformation on Biotech

Inspite of the exciting possibilities that biotechnology offers, "there is strong misinformation and hate campaigns being waged by certain groups with strong sentiments against genetic engineering. We have done studies on toxicity, allergenicity, and other concerns for our potential products, and we strive to ensure that the development of any GM rice is done in full compliance with national and international biosafety regulations. Unfortunately, the speculative negative side continues to predominate. I have learned the painful lesson that spreading fear is often easier than spreading good news."

The lady scientist recalls that she had agreed to be a co-supervisor of a PhD student with a university professor who held a negative view of the technology. She shared peer-reviewed journals and other documents and discussed research parameters with the student. She said that the student followed the scientific process recommended and empirical evidence disproved her main supervisor's contentions. "The important thing was that my student learned the scientific evidence herself, and even my colleague became more open to GM." Dr. Slamet-Loedin adds that she

[1] IRRI is currently developing healthier rice varieties as a potential way to help address hidden hunger and improve the nutrition of rice consumers. These varieties have the potential to reach many people because rice is eaten by half of humanity. IRRI and its partners are developing rice varieties that have higher levels of iron, zinc and beta-carotene (a source of vitamin A, also known as Golden Rice). These healthier rice varieties can complement current strategies to reduce micronutrient deficiencies.

has remained good friends with some members of civil society groups, some of them just totally misinformed that biotech products will inevitably lead to an oligopoly of a handful of private firms.

> **Regulation is certainly needed for the safe and responsible use of modern biotechnology, but we must determine what information is really needed versus information that might be nice to know.**

She believes that it is important to maintain credibility as a scientist. While some media interviews result in articles that highlight imagined negative consequences of a safe technology, her opinions are included nevertheless to provide a scientific perspective. "We have to show that, as scientists, we do not have hidden motivations," says the lady scientist. "We are doing our work to help contribute to the betterment of mankind."

Regulation Concerns

Dr. Slamet-Loedin also worries about the cost of stewardship and deregulation in nurturing a GM technology from the lab to the field, particularly the costs associated with deregulation processes. "Regulation is certainly needed for the safe and responsible use of modern biotechnology, but we must determine what information is really needed versus information that might be nice to know. For any agriculture product, it is difficult, if not impossible, to prove with absolute certainty the absence of risk; reasonable consensus is needed to agree when accumulated evidence is sufficient to show that certain GM products are as safe as their non-GM counterparts".

Dr. Slamet-Loedin says that many scientists are not well-informed about commercialization processes and many eventually believe that only major private sector actors can bear the costs of the release of GM products. Many barriers to the commercialization of GM products do not reside in the technology itself, but in the process that it undergoes to be approved for commercialization. "If we can prove that changes in the genome of a product is far less than when mutation technology is utilized, why should the former be regulated more heavily than the latter? "

The lady scientist believes that the next generation will determine the future of biotech. "We need to continue the discussion and share with the general public, especially the youth, the real nature of biotech products," she says. "Scientists have to speak out because, if not, who else will?"

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Wayne Parrott

- Professor of the Institute of Plant Breeding, Genetics and Genomics at the University of Georgia (USA)
- Member, Editorial Boards of *Plant Cell Reports, Plant Cell Tissue and Organ Culture,* and *Crop Science*
- Former Chair of the biotechnology section of the Crop Science Society of America and of the plant section of the Society for In Vitro Biology

> **“As long as there is malnutrition in the world, there is a place for biotech. As long as there are farmers who cannot progress past subsistence, there is a place for biotech. As long as agriculture uses too much water, fertilizers, and pesticides, and causes too much erosion, there will be a place for biotech.”**

There's Always a Place for Biotechnology

Kristine Grace N. Tome

A scientist knows science, does science, and fights for science. This is the kind of scientist you will find in Dr. Wayne Parrott. He does research and instruction on biotechnology and also devotes time fulfilling his role of engaging the public into science. His zeal in fighting for science is immeasurable.

It all started when he was studying agronomy at the University of Kentucky with much interest in plant breeding. "When I saw my first plant in a test tube I was hooked. It was also the time when scientists reported the first expression of foreign genes in plant cells, which made it evident it would be an exciting way to complement plant breeding." Since then, he held on to the promise of genetic engineering.

Research Focus

After finishing his undergraduate degree, he pursued MS and PhD degrees in plant breeding and plant genetics from the University of Wisconsin-Madison. Then in 1988, he joined the faculty of the Department of Agronomy, which is currently the Institute of Plant Breeding, Genetics and Genomics at the University of Georgia. His research is focused on developing tissue culture and gene transfer systems to introduce value-added traits for legumes such as soybean, alfalfa, and peanut. His research team is also geared toward developing techniques for multiple gene transformation, alternative selection systems, early analysis of transgenes, investigation on the specific role of centromere in maize, and transposon mutagenesis for gene discovery in soybean. Aside from doing research, he is also actively mentoring graduate students and postdoctoral fellows and teaching graduate-level courses in genetics and undergraduate courses in agroecology and sustainable agriculture.

Prof. Parrott has released a guide for environmental risk assessment of genetically modified organisms (GMO), with a second edition to be released soon, together with more than 90 journal articles in refereed publications and 14 book chapters. He has been part of the editorial boards of *Plant Cell Reports, Plant Cell Tissue and Organ Culture,* and *Crop Science*. He also served as chair of the biotechnology section of the Crop Science Society of America and of the plant section of the Society for In Vitro Biology, and is a fellow of both of these societies.

> "As a minimum, biotechnology in all its forms contributes to make breeding more efficient. At its best, biotechnology extends the reach of plant breeding to produce crops we could only dream about a generation ago."

Debunking Junk Science

Aside from his laboratory work, he also came up with the website *The GMO Crop (mis)Information Page*, which features links to information resources on GM crops for public use. He featured research articles on GMO that he considers "junk science" and gave the authors failing grades because of misleading methodology or results. For instance, he failed the article reporting that 93% of pregnant women and 69% of non-pregnant women tested had GMO-Bt protein in the blood. It got a failing mark because the detection test used is known not to work on blood samples. Because of Prof. Parrott's fervor in debunking junk science, he has

been invited to give talks on biotechnology in various countries.

When he was in Honduras, he talked to a farmer and saw first-hand the impact of what scientists like him do. "The farmer was not getting enough income from his land, so he got a part-time job in town. However, without his full attention, his land yielded even less. Then, he was given his first biotech maize. The labor savings meant he could still work in town, and yet provide all the labor needed by his farm without compromising yield. With the extra income, he was able to send his daughter to school and buy seed for the following season. He never wants to go back to his old varieties. Multiply his experience by 18 million smallholder farmers, and the impact is self-evident."

> **"There are still millions of smallholder farmers being condemned to perpetual poverty by Western-financed NGOs who deny them the right to use improved seeds under the pretense of protecting their health, livelihood, traditions, or culture."**

Daunting Challenges

Prof. Parrott views that the most daunting challenges of biotechnology may not be climate change or pests but fear and emotion which are not technical issues that can be addressed methodologically through science. "The challenges are based on fear and emotion, and do not respond to reason and logic; fear is propagated by various non-government organizations (NGOs) who profit richly from their activities. I do not think any of us saw that the rise of these groups was on the horizon in the early days of biotech. Now, they have chased away capital and talent, and erected unsurmountable regulatory systems with no foundation in science. The tragedy in this picture is that there are still millions of smallholder farmers being condemned to perpetual poverty by Western-financed NGOs who deny them the right to use improved seeds under the pretense of protecting their health, livelihood, traditions, or culture."

Because of this challenge, Prof. Parrott has reached out to legislators and regulators throughout his native Latin America and other countries to equip them with knowledge on making a functional regulatory system that ensures safety of biotechnology products. He also did volunteer work as scientific advisor to the Biotechnology Committee of the International Life Sciences Institute, which serves to bring the best science available to help guide those who formulate regulatory policies.

> **"Biotech remains the most powerful and flexible set of technologies we have when deployed within the context of a comprehensive rural development strategy that includes education, infrastructure, and advanced agronomic practices."**

Impact of Biotech

Prof. Parrott views the benefits of biotechnology as a dream come true. "Sadly, almost no one is aware of the huge impact that plant breeding has had on their lives. Most are clueless what living with yields from 1900 would be like, and do not realize the impact it would have on prices, land use, and the agricultural footprint in general. Ultimately, the wealth of mankind starts with agricultural productivity. So, first and foremost, I am a believer in plant breeding. As a minimum, biotechnology in all its forms contributes to make breeding more efficient. At its best, biotechnology extends the reach of plant breeding to produce crops we could only dream about a generation ago."

Despite opposition and other challenges of biotechnology, Prof. Parrott stands by his belief that there will always be a place for it. "As long as there is malnutrition in the world, there is a place for biotech. As long as there are farmers who cannot progress past subsistence, there is a place for biotech. As long as there are crop failures, there is a place for biotech. As long as agriculture uses too much water, fertilizers, and pesticides, and causes too much erosion, there will be a place for biotech. Biotech remains the most powerful and flexible set of technologies we have when deployed within the context of a comprehensive rural development strategy that includes education, infrastructure, and advanced agronomic practices."

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Photo credit: *Columns*, University of Georgia Online Newsletter

Championing the Cause

Anwar Nasim

- Secretary General of the Pakistan Academy of Sciences
- Father of Biotechnology in Pakistan
- Presidential Awardee: Pride of Performance and *Sitara-i-imtiaz*

> **I strongly believe that use of agricultural biotechnology has enormous potential to provide food and feed to all, not only increasing production but by reducing farm inputs such as pesticide, fertilizers, herbicides and water.**

A Non-Government Individual Leads Biotech Efforts

M. Iqbal Choudhary, Saifullah Khan, and Sammer Yousuf

In a developing world, things move in a slightly different manner. The paradigm of development has different dynamics. Systems often do not exist. Individuals play key roles. They are the champions of change, good or bad. Changes are made "despite the government." These individuals are called non–government individuals (NGIs), a term coined by Dr. Anwar Nasim, in parallel to the well known non-government organizations (NGOs). NGIs are towering personalities who catalyze change, contribute toward the betterment of society, and redefine the future of nations. They emerge out of nowhere and leave profound marks behind them.

One such NGI is Dr. Anwar Nasim S.I., the Father of Biotechnology in Pakistan. In the book *Biotechnology in Developing Countries: Prospects and Challenges* which Dr. Nasim co-authored, the vision and mission statements for biotechnology are well elucidated:

> **Vision**: Attaining new heights in biotechnology research, and shaping it into a tool, to act as an engine of socio-economic development;
> **Mission**: Realizing biotechnology is an intellectual enterprise of mankind to provide impetus that fulfills this potential and utilizing it to the advantage of humanity and technological empowerment of the developing world.

Dr. Nasim is a big name in the field of science, especially in biotechnology, in Pakistan. Currently the secretary general of the Pakistan Academy of Sciences, Dr. Nasim is actively engaged in the promotion of science. His main areas of interest include molecular biology, biotechnology, and genetic engineering.

In 1995 and 1999, he received two national awards from the President of Pakistan: the Pride of Performance and *Sitara-i-imtiaz*. These prestigious awards are given to eminent personalities for their most valuable contributions in their respective fields.

> "Effective and judicious applications of modern agricultural biotechnology can play an important role in the sustainable agriculture development and economy of Pakistan as well as in improving the livelihood of poor farmers."

He was awarded a gold medal by the University of the Punjab, Lahore, in 1957 for securing first position in his pursuit of an MS in Botany degree. Soon after, Dr. Nasim then went to Edinburgh University (UK) and completed his PhD in biochemical genetics in 1966, the first Pakistani who specialized in this field. He started as a researcher/scientist at the Biology and Health Physics Division of the Chalk River Nuclear Laboratories (Canada) and later became a member of the National Research Council of Canada.

Biotech for Pakistan

During his research engagement in Canada, he remained in close touch with his motherland, Pakistan, through numerous short visits and extensive dialogues with researchers. As an active scientist of international stature, he witnessed the great progress in the field of biotechnology

the world over. He could see the benefits that biotechnology could bring to the world.

"Pakistan's growing population requires careful planning and coordinated efforts to cater to the country's present and future needs. The most important of these human needs are food, fodder, and fiber. These all come from the agriculture sector; it is, and will remain the most important sector in the economy," Dr. Nasim explains. The imbalance in food intake and crop production ratio is a big challenge for developing countries such as Pakistan. In addition to the heavy use of pest/insect controls, low crop yields are contributing to the poverty of farmers. "Effective and judicious applications of modern agricultural biotechnology can thus play an important role in the sustainable agriculture development and economy of Pakistan as well as in improving the livelihood of poor farmers. However, it demands national commitment for increased production of food, fodder, and medicine," he asserts.

Dr. Nasim was concerned about the poor state of scientific research, particularly in biotechnology, in Pakistan. The impediments include lack of trained manpower, poor institutional infrastructure, sustainable financial support, and lack of commitment by the national government. Dr. Nasim worked in getting government officials to understand the importance of biotechnology in increasing production, decreasing production cost, and improving the living standards of people.

Establishment of Biotech Centers

The turning point in the status of agri-biotechnology in Pakistan was in 1981 when Dr. Nasim visited his home country. He organized the first course on biotechnology in Faisalabad and trained a large number of young scientists, who are now among the most prominent scientists in the country. He proposed the establishment of a national biotechnology institution in Pakistan. During this historical visit, he met with the chairmen of the Pakistan Atomic Energy Commission and the University Grant Commission and emphasized the need to act quickly. He told them, "The National Institute of Genetic Engineering is imperative for the country within the shortest possible time to bring Pakistan at par with the developed world. Unlike electronics where Pakistan is far behind, genetic engineering is a field where the West is only a few years ahead. There is no apparent reason, therefore, to let this gap widen."

During his subsequent visits, he also proposed the establishment of an institution of genetic engineering in Pakistan. As a result, two premier institutions, the Centre of Excellence in Molecular Biology in Lahore and National Institute of Biotechnology and Genetic Engineering in Faisalabad were set up, thus, opening the doors to applied and basic research in biotechnology.

His valuable and continuous efforts were also recognized internationally and he was awarded by the Overseas Pakistani's Institute for his role in promoting science in Pakistan.

> **"Unlike electronics where Pakistan is far behind, genetic engineering is a field where the West is only a few years ahead. There is no apparent reason, therefore, to let this gap widen."**

Making a Choice

Dr. Nasim says the introduction of modern technologies always plays a major role in the development of the agriculture sector. He noted that traditional methods in agriculture were not sufficient to feed millions of additional mouths every year. He challenged higher authorities, saying that "Traditional plant breeding has limited potential as most of it has already been exploited under the Green Revolution and no major breakthrough in food production looks feasible. Under these circumstances, we have only one

choice of using technology for the benefit of our own people. We need to explore non-traditional methods of increasing farm production."

He continues: "I strongly believe that use of agricultural biotechnology has enormous potential to provide food and feed to all, not only by increasing production but also by reducing farm inputs such as pesticides, fertilizers, herbicides, and water. An improvement of our environment will result if we use zero tillage and less fertilizers because there would be less contamination of the aquifer's water tables."

As the science advisor at COMSTECH (OIC's Standing Committee on Scientific and Technology Cooperation) in 2010, he was actively involved along with Dr. Atta-ur-Rahman FRS, coordinator general of COMSTECH, in the development of science and technology in the 57 OIC member countries. He strongly advocated the role of biotechnology application to improve the economy in the Muslim world.

Biotech and Islamic Nations

"For Pakistan, as in other countries of the world, especially the Islamic nations, where the main economic activity is based on agriculture, biotechnological application such as genetic engineering can be utilized to improve production both quantitatively and qualitatively by transferring more precisely and efficiently the genes of interest. Molecular markers can be utilized to make plant breeding more precise and efficient by marker assisted selection. This may result in saving time and resources by early selection and roughing out undesirable genotypes at an early stage. Similarly, this technology may play a vital role in the sustainability of the environment," Dr. Nasim explains.

In the same vein, tissue culture techniques are being utilized for mass multiplication of true-to-type and disease-free plants of a required quality throughout the year. This is very important for crops where large-scale replacement of clean planting material is required due to viral infection. Example of major crops that can benefit from these techniques are citrus, pineapple, banana, and many more. Moreover, biotechnology in developing countries can influence the human health by transferring health beneficial traits into food plants. These include lower saturated fat, increased omega-3 fatty acid, and increased isoflavone content. Consumers can be rest assured that agricultural biotechnology is safe," Dr. Nasim elaborates.

In 2006, Dr. Nasim proposed the establishment of the Pakistan Biotechnology Information Center located at the LEJ National Science Information Center, International Center for Chemical and Biological Sciences in the University of Karachi. He remains as patron of the center.

"Biotechnology remains to be my passion. I am always available to attend almost each and every event where biotechnology is the subject of discussion. The existence of people who oppose the technology is nothing new. In human history, there were always groups who oppose change. There is a great potential to serve humanity. Biotechnology is based on deep knowledge, it is not black magic. People who oppose it lack the data to support their arguments," he explains.

Dr. Nasim is a genuine champion of agri-biotechnology as a vehicle for the betterment of mankind. "We must advance our knowledge of biotechnology and make its applications our mission for the sake of humanity, not only in Pakistan, but the world over."

Emil Q. Javier

- Former Minister of Science and Technology (Philippines)
- Former President, University of the Philippines System
- Former President, National Academy of Science and Technology
- Chairman of the Coalition for Modern Agriculture Modernization in the Philippines

> **“I know enough of the science to understand that it has many potential useful applications. There are enough safeguards. The benefits outweigh the risks, which are speculative and exaggerated.”**

Biotech Visionary

Clement Dionglay

Scientists play a number of roles in society. Influential and respected, they can be supporters and advocates for different causes, in addition to their research engagement. Some also see the need to inform the public and help them understand science better. Such is the case of Dr. Emil Q. Javier, who has held four leadership positions: chancellor of the University of the Philippines (UP) Los Baños, president of the National Academy of Science and Technology (NAST), minister of science and technology, and president of the UP System.

Dr. Javier is a strong supporter of science particularly crop biotechnology. "I know enough of the science to understand that it has many potential useful applications. There are enough safeguards. The benefits outweigh the risks, which are speculative and exaggerated."

He states that the country's current regulatory protocols are very rigid and science-based, and crops developed through genetic engineering technologies are equivalent, or maybe even safer, than those bred through conventional plant breeding.

"There is nothing to fear nor wonder about the transfer of DNA across widely unrelated forms of life, e.g. DNA from bacteria to plants and animals. These merely confirm the theory of evolution — that all living things have a common genetic blueprint (our DNA) because all life originated from single-celled organisms billions of years ago."

It was 1962 when Dr. Javier, then a young graduate student of agronomy at the University of Illinois, realized that the future of agriculture will revolve around the DNA and the manipulation of genes not at the level of populations and individuals but at the sub-cellular level. The DNA helix had been deciphered a decade earlier, and he anticipated that agriculture would take a different path in the future.

"I realized that the new ballgame will have to be in genetics and biochemistry. So, in Illinois, I spent more time in the arts and sciences faculty than in agriculture. I studied basic biochemistry, microbiology, genetics, and physiology, trying to understand where this new world of plant breeding was going into."

Institutional Efforts

Years later, Dr. Javier took the initiative to strengthen plant breeding activities in the country and proposed a new institute to President Ferdinand Marcos who issued Presidential Decree No. 729 in 1975, establishing the Institute of Plant Breeding (IPB) in the University of the Philippines Los Baños (UPLB), appointing Dr. Javier as the Institute's first director.

Dr. Javier recalls, "President Marcos was very supportive of agriculture as well as of science and technology. It did not take much convincing to persuade him to establish an institute of plant breeding. When we started IPB, we organized strong laboratories for biochemistry, genetics, virology, analytical chemistry, and tissue culture."

An advocate of interdisciplinary and multidisciplinary approach to collaboration, Dr. Javier brought into the Institute a strong mix of experts from across disciplines and lines of work. "From the beginning, while we were preoccupied with conventional plant breeding, we were anticipating work on DNA manipulation. We were preparing for genetic engineering."

But he recognized that the new trend in agriculture has more applications beyond plant breeding. When Dr. Javier became the chancellor of UPLB, he

made sure that the modern tools were also applied in forestry, food technology, veterinary science, and the rest of agriculture. He then proposed the establishment of the National Institutes of Biotechnology and Applied Microbiology for which he was likewise appointed as founding director.

In 1981, President Marcos brought Dr. Javier to his cabinet as minister of science and technology and director general of the National Science and Technology Authority (now Department of Science and Technology). As science minister, he formed sectoral councils, established regional offices, promoted a dedicated science career service in government, and developed the concept of science communities. Dr. Javier also co-founded the Crop Science Society of the Philippines to foster sharing of scientific human resources, information, and materials for crop improvement.

When he became the UP president in 1993, Dr. Javier created three more biotechnology research institutes with specific niches in pharmaceutical applications, industry and energy, and marine industry in the UP campuses in Manila, Diliman, and the Visayas.

As NAST president, Dr. Javier was principal author of *Philippine Agriculture 2020 (PA 2020): A Strategy for Poverty Reduction, Food Security, Competitiveness, Sustainability, and Justice and Peace* in 2011. PA 2020 is a medium-term strategic plan for the development of the agricultural and natural resource sectors of the country, conceived from NAST-organized consultations and workshops with scientists, farmers, entrepreneurs, and other stakeholders. Biotechnology is identified in PA 2020 as a tool to increase agricultural productivity through the development of quality seeds and crops and livestock with beneficial traits.

A practicing farmer himself, Dr. Javier emphasized that biotechnology has transformed the Philippine corn industry from being highly import-dependent into an almost self-sufficient one. "The Philippines has a long history of biotech crop adoption. Our own corn farmers had been planting Bt corn for more than a decade, and they have benefited through increased yields and reduced pesticide use. The technology is so practical and profitable that small Filipino farmers purchase the expensive GMO corn hybrid seeds without subsidy from the government."

Corn's Competitive Edge

Dr. Javier notes that "the country's yellow corn feed sector has found a new competitive edge due to the large-scale adoption of Filipino corn farmers of high yielding genetically modified (GM) corn hybrids. Corn farmers in the Philippines planted 813,000 ha of GM corn in 2014, or 57% of the total area planted to corn in the country. Farmers who planted GM corn harvested 7–8 tons per hectare, compared with the 4.4-4.9 tons per hectare from conventional hybrids."

"In theory, we can compete in the world trade for corn feed. However, since we have yet to fully satisfy the domestic demand for animal feed and industrial uses, the more realistic immediate objective is to further increase supply of competitively priced quality feed corn to strengthen the competitiveness of our poultry and swine industries. This will bring down the cost of chicken and pork for domestic consumption as well as for export," Dr. Javier explains.

> **"The technology is so practical and profitable that small Filipino farmers purchase the expensive GMO corn hybrid seeds without subsidy from the government."**

Despite the success of biotech corn adoption in the Philippines, Dr. Javier voices the concern of many Filipino scientists today. The rapid progress made all over the world in the development of new products and processes using genetic engineering have profound impacts on farm productivity, farmers' incomes, health and nutrition, integrity of the environment, and economic competitiveness. Yet, he says, the application of the *Writ of Kalikasan*[1] on agricultural biotechnology research

has tied their hands. "We are very close to commercializing our first GMO crop developed by Filipino scientists, but that is now on hold." There is currently a Court of Appeals order to stop field trials of Bt eggplant and an appeal by the proponents is with the Supreme Court.

Their frustration is even more aggravated due to recent developments in modern biotechnology, which can help the country become more food secure and economically competitive. Aside from Bt eggplant, Dr. Javier cites opportunities such as the need to develop drought-tolerant sugarcane to help the country's sugar industry, which is facing heavy competition from other Southeast Asian countries as well as from Australia and Brazil.

Eroding Gains

"We have the training and expertise to exploit these opportunities to advance our national interests. We were so much ahead among developing countries in training people, establishing institutions, and instituting a regulatory framework so much so that our neighbors like Thailand, Indonesia, and Vietnam and several countries in Africa have sent their own regulators to study and observe how the Philippine biosafety system works. These gains are now slowly eroding before our eyes."

Dr. Javier continues to support science and technology and agriculture. He is involved in efforts to educate the public about science and their potential to improve people's access to food and health and to emphasize the need for modern biotechnological innovations for a food-secure Philippines.

He is the chairman of the Coalition for Agriculture Modernization in the Philippines (CAMP, Inc.), a non-stock, non-profit organization of volunteers from business and industry — academe, government, professional groups, and international organizations — driven by a patriotic call to contribute their expertise and resources to help raise productivity, competitiveness and incomes of farmers in the country.

The scientist also writes a weekly column "*Why Not?*" in the Manila Bulletin, the second oldest newspaper in the Philippines. He starts his articles with a Robert Kennedy quote, "*There are those who look at things the way they are, and ask why… I dream of things that never were, and ask why not?*" His column covers topics in agriculture and, science, particularly modern biotechnology. It is widely read and followed not only by members of the science community but also by the general public. Asked what compelled him to write a column, his answer is simple. "As a Filipino and as an academic, it is my obligation to make our leadership and our people aware of the potential of modern science to advance our national purposes."

[1] Writ of Nature, a legal remedy in Philippine law for persons whose constitutional right to "a balanced and healthful ecology" is violated by an unlawful act or omission of a public official, employee, or private individual or entity.

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Mohd Nazlee Kamal

- CEO, BiotechCorp (Malaysia)
- Former Professor at the University Technology Malaysia

> **Biotechnology and bio-based applications offer a technological platform with immense potential to deliver advancements in the fields of healthcare, agriculture and industry. In Malaysia, our challenge is to develop an ecosystem that is conducive to the growth, development and adoption of these technologies.**

Championing Biotech and Bioeconomy Initiatives in Malaysia

Mahaletchumy Arujanan and Brian Chow

Malaysia is one of the few countries in Asia to have a national policy dedicated to biotechnology. The National Biotechnology Policy (NBP) was formulated in 2005 and the Malaysian Biotechnology Corporation or BiotechCorp is the lead development agency for the biotechnology industry in the country. Dr. Mohd Nazlee Kamal, a chemical engineer by training and former professor at the University Technology Malaysia for 10 years, is CEO of BiotechCorp. He occupies the hot seat of biotech in the country as it has an investment target of RM15 billion (USD4.3 billion) by 2020.

"I am proud to be involved in formulating the National Biotechnology Policy (NBP) and the Bioeconomy Transformation Programme (BTP)," says Dr. Kamal who spearheads and implements both policies. As BiotechCorp enters its 10th year, Malaysia has witnessed encouraging development in terms of investment and industry growth.

"Biotechnology and the bio-based domain is an exciting and rapidly expanding area. Leading the sole economic developer for the bio-based sector in Malaysia is a huge responsibility to shoulder, however, with it also comes a sense of fulfillment as well."

"Biotechnology and bio-based applications offer a technological platform with immense potential to deliver advancements in the fields of healthcare, agriculture and industry. In Malaysia, our challenge is to develop an ecosystem that is conducive to the growth, development and adoption of these technologies. It is an exciting challenge. Our companies need to increase technological content in their products and encourage more innovation," adds the BiotechCorp CEO.

"Through biotechnological advancements, we can create new and less invasive medical solutions to save lives as well as reduce unwanted side effects in patients. Bioprinting for instance is an exciting breakthrough. In the future, we might be able to print 3D organs for transplantation! It does not stop there. We are now able to provide cheaper, more reliable methods of cultivating agricultural products by creating better plant cultivars that require less land usage and less pesticides. We can make better quality food and feed with these improved plant characteristics. And finally, we can also develop cleaner and more sustainable forms of energy and fuel by utilizing environmental-friendly options such as biomass. Though these may all sound far-fetch, the fact is, it is happening right now as we speak. Truly, when it comes to biotechnology, the only limit is our imagination. The prospects of what we could further achieve in the coming years get me excited," Dr. Kamal notes.

The Biotech Aspiration for Malaysia

The ultimate objective of the NBP is to transform the biotechnology sector into one of the key economic pillars of Malaysia. With its pro-business and pro-science policies, Malaysia is an excellent destination for biotechnology companies and investors.

"Through NBP, biotechnology will not only contribute to economic gains of the country but would produce significant benefits to the society," says Dr. Kamal who envisages the country to join the ranks of other developed countries and major biotechnology and/or bioeconomy players such as Canada, the United States and South Africa in the foreseeable future.

Dr. Kamal sees adapting the best of the U.S. and its initiatives might be the game changing plan for Malaysia. The education system that produces innovative and productive students, research at universities, funded and driven by industry and tertiary education reflect the current needs of the industry, which is up to date and relevant. As a result, the American education system produces a pool of talented and innovative workforce. These are the main ingredients needed for growing the biotechnology industry.

> **"Truly, when it comes to biotechnology, the only limit is our imagination. The prospects of what we could further achieve in the coming years get me excited."**

Dr. Kamal envisions putting in place similar initiatives to encourage relevant biotechnology companies to work closely with local universities and to provide sufficient funding platform for our researchers. BiotechCorp has already implemented programs to encourage more collaborations between universities and industry through public-private partnerships. A key component for building the biotechnology industry and strengthening the funding ecosystem in the country is the need for experience and technical expertise. To address the issue, BiotechCorp aims to partner with key institutions in creating University-Industry Centre of Excellences (CoEs) for the bio-based sector.

BiotechCorp has also forged strategic partnership with international partners such the University of California Institute for Quantitative Biosciences (QB3) and the Larta Institute — two prominent organizations that are vital in advocating entrepreneurship and public private partnership for training of local scientists, entrepreneurs and start-ups". In the long run, it is hoped that all strategies will help achieve the objective of making Malaysia a global biotech player," Dr. Kamal says.

Thoughts on Emerging Technologies

Dr. Kamal feels genetically modified (GM) crops, cloning of tissues, gene therapy and synthetic biology are controversial and complex with many concerns surrounding them, largely due to ethical concerns raised by various parties, be they scientists, academics, activists, industry, religious representatives or consumer bodies. "The ethical debate is very subjective itself, in the way that values or standards that people use to determine whether the actions are good or bad differ."

Being an old hat in this field, he understands that biotechnology is not spared from this global science debate, citing genetic modification as an example which is one of the core components in modern day biotech technique. "Many see it as human intervention in altering the blueprint of life itself and hence, an unnatural act. Others may believe that biotechnology disrupts the natural order and violates the limits of what humans are ethically permitted to do. But on the other end, some may also share the view that life sciences/ biotechnology are merely tools for progress designed to benefit mankind," stresses Dr. Kamal.

Responsible Use of Biotech

He further explains that there are pros and cons to the argument. "Not limiting to biotechnology, what is more important is these knowledge and/or technologies are being used responsibly. It is true that there will be some universal ethical concerns that we must consider and to address accordingly. However, these technologies present opportunities for progress faster than what nature can offer."

"If done responsibly, these are all very promising technologies, yielding enhanced products to provide social and economic benefits, without compromising health, safety and the environment. Because of these reasons, I strongly support these emerging technologies," proclaims the CEO.

Fighting Pseudoscience

Dr. Kamal sees the internet as a double-edged sword. He says it is disheartening to see all the misconception revolving around biotechnology. Most people in general, without a basic understanding of biotechnology, are vulnerable to misleading information found on the internet. He urges everyone to bear in mind that not all information is reliable information and some basic understanding of biotechnology may enable readers to distinguish between trustworthy from misleading ones. Practitioners of pseudoscience and scaremongers spread inaccurate and false information through the exploitation of the general population's lack of understanding, not only in biotechnology but perhaps any other topic you can think of.

"People tend to fear what they don't understand. And biotechnology is something a lot of people assume is too technical or too complicated to comprehend. Truly, this is not the case," laments Dr. Kamal. He does not underestimate the need to promote biotechnology awareness and education with a goal to spread scientific awareness to the public and other important stakeholders relating to modern day biotechnology.

"We have similar initiatives in Malaysia. For example, the Malaysian Biotechnology Information Centre (MABIC) is a non-profit organization dedicated to building the public 's understanding and awareness of biotechnology. For the past 10 years, MABIC has conducted various outreach programs targeting a broad spectrum of audiences," explains Dr. Kamal.

Vandalism on GM Field Trials

Dr. Kamal's one word to describe this act is "wrong". "I wonder whether those responsible for the vandalism realize the consequences of the action. They may have a different point of view with regard to GMOs, however field trials are also the culmination of years of research and are equally the hard work done based on the different views held by well-intentioned scientists and researchers. Vandalism of GM crops will definitely put academic and research freedom at risk, not to mention the act of vandalism itself is against the law in civic societies. "

If any good can come out of vandalizing or destroying field trials, those who are responsible will put themselves under greater scrutiny in the future. Each person's opinion is valid as long as it is based on accurate information and any action taken should abide by the law," the BiotechCorp CEO opines.

Benigno D. Peczon

- Former Vice President of United Laboratories (Philippines)
- First President of the Biotechnology Association of the Philippines, Inc.

> **Technological advances change cultures and the development of nations. In the same manner that cellular phones and communication devices and networks have opened up a whole new range of possibilities, biotechnology will affect nations.**

Biotechnology, a Tool to Help Humanity

Rhodora R. Aldemita

"I am not so much a believer of biotechnology per se as I am a person who believes that each and every individual on earth should be part of the solution and not be part of the problem. I see biotechnology as a tool. Since I consider myself to be a scientist, I seek the best solutions based on demonstrable data. As passengers of Spaceship Earth, we must collectively seek the best solutions that redound to the common good."

A chemist, Dr. Benigno D. Peczon or Doc Ben as friends fondly call him, got interested in biotechnology while doing basic work on diabetes in the 1980s. The production of human insulin in 1978 at Genentech through biotechnology caught his attention. Prior to 1978, insulin was isolated from porcine and bovine pancreas in limited amounts at a high cost and with some adverse effects on a significant percentage of diabetics. That biotechnology breakthrough catalyzed his interest to know more.

"I endeavored to read about biotechnology and attend as many biotechnology conferences as were available to a pharmaceutical researcher residing in the Philippines," Dr. Peczon revealed. His formal education at the University of the Philippines Los Baños and Purdue University and his research work at Oklahoma State University, Harvard Medical School, Schepens Eye Research Institute in Boston, and University of Kansas School of Medicine facilitated his understanding of biotechnology. His publications on enzyme kinetics, membranes, nature of tissues, and analytical chemical methods helped him better understand biotechnology.

Fellow Purdue University alumnus Dr. Kin-Ping Wong, one-time California State University at Fresno dean of graduate studies, kept him informed about products such as a glycoprotein that enhances production of red blood cells, growth hormones, and medical diagnostic kits, all of which came from biotechnology.

When he returned in 1983 as a "balik-scientist" (scientist returnee) to the Philippines, Dr. Peczon was already well-prepared for the big challenges explaining the benefits of biotechnology. Thus, during and after serving as a department manager, senior scientist, and later vice president of the Chemistry and Quality Assurance Division from 1983 to 2002 at the largest pharmaceutical company, United Laboratories (UNILAB), based in the Philippines, Dr. Peczon became an advocate of biotechnology.

Identified as Biotech Champion

In the 1990s, then secretary of the Philippine Department of Trade and Industry (DTI) Cesar Bautista identified biotechnology as a 'sunrise' industry. DTI identified Dr. Peczon as a biotechnology champion. With the help of DTI, the Biotechnology Association of the Philippines, Inc., (BAPI) was created, with Dr. Peczon serving as its founding president. After a DTI-funded mission to Singapore, Dr. Peczon became more convinced of the potential of biotechnology. He says, "The Singaporean government embraced biotechnology through awarding of significant grants to attract the best and brightest scientists from all over the world, including Sir Ian Wilmut, a member of the team that cloned the first mammal, Dolly the Sheep."

Dr. Peczon became involved in biotechnology education activities, especially for the youth. He recounts that, "Dr. Delfin B. Samson, Jr., then president and CEO of UNILAB, cognizant of the promise of biotechnology, asked me to create the UNILAB Mobile Biotechnology Education Program (UMBEP) in the late 1990s. The program was intended to introduce high school students to

biotechnology." And so, "with a generous financial outlay from UNILAB and help from National Scientist Lourdes J. Cruz and toxicologist Dr. Flerida A. Cariño (a member of the Philippine Committee on Biosafety), we created the program. With equipment unique to biotechnology transported in a van, the UMBEP was deployed in over 100 high schools in the country. Wherever the van went, invariably, the group was invited back, indicating openness to this game-changing tool."

In 2001, Dr. Peczon already perceived that "biotechnology would have a major impact not only on the health sector but also on agriculture." By 2002, with the addition of agriculture to its scope, BAPI morphed into the Biotechnology Coalition of the Philippines (BCP). Under his leadership, BCP organized many symposia and used print media, radio, and television to address biotechnology issues. His passion as a biotech advocate never faltered, even while encountering naysayers, drawing inspiration from Albert Einstein who once said, "Great spirits have always encountered violent opposition from mediocre minds."

> **"...as more people shed the shackles of ignorance, safe and responsible use of biotechnology will be widespread."**

In early 2002, the Department of Agriculture Policy and Planning Department under Undersecretary Segfredo Serrano completed the draft of Administrative Order No. 8, the guidance document covering the import for direct use, confined field tests, multilocational trials, and commercialization of genetically modified (GM) crops. Dr. Peczon recounts, "BCP, together with noted academicians, scientists, civic leaders, and farmers, worked in concert to lend their names and integrity to vouch for the safe and responsible use of biotechnology throughout the country. The naysayers were Greenpeace and locally based organizations that mirrored the viewpoints of Greenpeace. They simply repeated the mantra, 'Are GM foods safe?' without ever having shown science-validated data that, indeed, biotech food was not substantially equivalent to the genetically unaltered food."

Dr. Peczon's leadership of BCP included a well-attended hosting of the Third Asian Biotechnology Meeting in Manila in 2006. More than 100 hundred participants gathered to discuss biotechnology issues, including policies governing its acceptance and adoption and future biotech crops for Asia.

Struggle for Biotech Acceptance

He observed that, after the Philippine Government approved commercialization of biotech corn in 2002, the crop was readily accepted by farmers. Since that year, an ever increasing number of farmers have planted GM corn, with a corresponding increase in hectarage. There was also a substantial increase in public acceptance of biotechnology, attributed in part to its embrace by opinion leaders such as philanthropist extraordinaire Bill Gates and former U.S. Secretary of State Hillary Clinton. Nonetheless, Dr. Peczon remarks, "The struggle for acceptance is far from over because in 2013, through a court ruling based on a *Writ of Kalikasan*, Philippine scientists are currently prevented from performing tests aimed in fact to answer the very questions raised by opponents to the utilization of modern biotechnology."

With the turn of events in the Philippines, Dr. Peczon is not relenting. He opines, "Technological advances change cultures and the development of nations. In the same manner that cellular phones and communication devices and networks have opened up a whole new range of possibilities, biotechnology will affect nations."

He adds that "The unprecedented adoption by millions of resource-poor farmers has become a 'game changer' in the sense that proper utilization of modified seeds produces so much more: increased yield, reduced need for pesticides,

and adoption of no-till land preparation that reduces soil erosion. As more research for better versions of rice, cassava, sweet potato, millet, and other crops — in terms of increased yield and drought, pest and disease tolerance and other desirable characteristics, — and for greater capacity to address pollution and climate change are completed, thinking men everywhere cannot help but realize what a boon biotechnology has to offer."

Potential for Corn Export

Dr. Peczon pointed out that "prior to 2002 and for a few years thereafter, the Philippines purchased corn from abroad to meet the local feed demand for poultry, swine, cultured tilapia, and other animals. In 2002, the average national yield using non-biotech corn was 2.65 tons per hectare per crop. Biotech corn yields are in the 4-9 ton-per-ha per-crop range. Having seen the increased yield, without any government support for the more expensive biotech corn seeds, farmers now plant about half the annual crop to biotech corn. With the increased yield, the Philippines is now on the cusp of exporting corn. Certainly, the availability of this locally produced biotech corn helps the Philippine compete in the international food market."

Dr. Peczon also believes that "as more people shed the shackles of ignorance, safe and responsible use of biotechnology will be widespread. People will demand better access to the fruits of this technology. Consumers will want a free choice in the products they consume, regardless of what pressure groups say or do. Moreover, in the primary health care arena, presently marketed biotechnology products and future applications are just too awesome to ignore. Let us hope and pray that onerous overregulation will not dry up the funding needed to reap the fruits of biotechnology."

Sutat Sriwatanapongse

- Former Director, Thailand Biodiversity Center
- Former Deputy Director, National Center for Genetic Engineering and Biotechnology (Thailand)
- Former Regional Maize Specialist for North Africa and Middle East Region, CIMMYT

> **“Modern technology, such as plant biotechnology and genetic engineering, is part of the arsenal to improve agricultural production not just to produce more food and feed, but also to develop value-added products in the areas of nutraceuticals and medicinal products.”**

Giving a Helping Hand to Biotech in Thailand

Supat Attathom and Mariechel Navarro

Dr. Sutat Sriwatanapongse, has long retired from public service but his commitment to see biotechnology thrive in Thailand keeps him busy and on the go. The former agronomy professor of Kasetsart University has already put in so much time and energy in getting government support for biotechnology. One senses a level of frustration and disappointment toward what he feels is lack of political will, but Dr. Sriwatanapongse does not lose hope that under the new coalition government, supporters in the Cabinet will provide an opportunity to encourage research and commercialization of biotech crops.

"Modern technology, such as plant biotechnology and genetic engineering, is part of the arsenal to improve agricultural production not just to produce more food and feed, but also to develop value-added products in the areas of nutraceuticals and medicinal products," Dr. Sriwatanapongse explains.

Early Foray into Biotech

Dr. Sriwatanapongse looks back at how he got involved in biotechnology. He had been invited to attend a meeting (where he was the only Asian) at Michigan State University in the mid-1980s. A distinguished professor from the University of Hawaii had stood up and encouraged participants to begin work on biotechnology, the new buzz word with its foundations in genetics, biology, and cytogenetics. "I was amazed at its potential use in agriculture, medicine, and industry." His segue to biotech was smooth, having earned MS and PhD degrees in plant breeding and genetics from Purdue University and Iowa State University, respectively. He eventually worked at the International Maize and Wheat Improvement Center (CIMMYT) as regional maize specialist for North Africa and the Middle East Region for 5 years.

"It is ironic that neighboring countries such as China, India, and the Philippines have been planting biotech crops such as Bt cotton and stacked-trait corn for over a decade, while Thailand continues to import many products and their derivatives from genetically modified (GM) cotton, soybean, and corn grown in countries that allow their planting," Dr. Sriwatanapongse says in disbelief. "China and India are exporting Bt cotton while the Philippines has attained self-sufficiency in corn production. Why can't we do the same?"

Dr. Sriwatanapongse reflects on the country's foray into the technology. "Thailand started on the right foot with its support of biotechnology in the early eighties. The Minister of Science and Technology (MoST) fully supported it and the government even sent an application to the United Nations when it was looking for a potential host country for the International Centre for Genetic Engineering and Biotechnology (ICGEB)." This center, eventually established in Delhi, India, is dedicated to advanced research and training in molecular biology and biotechnology with special regard to the needs of developing countries.

Establishment of BIOTEC

"Instead of getting discouraged from losing to India, the government decided to establish a local version of the center as a regular agency under the MoST. In 1992, the National Center for Genetic Engineering and Biotechnology (BIOTEC) became part of the National Science and Technology Development Agency (NSTDA). Dr. Sriwatanapongse was deputy director for 7 years before he became the first director of the Thailand

Biodiversity Center, also an organization under NSTDA.

His hands-on experience in the field enabled him to share in the glory of public sector-led research that put Thai researchers at par with the global science community. "We had good networking among five local universities then; we were able to send as many as 300 students for PhD degrees in UK, Germany, US, and Australia. All came back and worked in universities or research and development institutions. State-of-the-art laboratories and work facilities were built over time," Dr. Sriwatanapongse claims. Many GM crops were developed such as tomato, papaya, cotton, and chili pepper. Other imported transgenic plants were field-tested including GM papaya, tomato, and cotton. Results were significant and several products went into the pipeline for eventual commercialization. "We were advanced in tissue culture and genetic engineering. Thailand was the center for training on biotechnology in Southeast Asia."

> **"Farmers continue to ask why they cannot plant GM papaya. We feel for them but we are helpless."**

External Pressure

The clamor from opposition groups to stop work on transgenic crops won over the dedicated work of scientists. "Elected politicians were not ready to take the risk of the opposition's ire. The Ministry of Agriculture was about to do extensive field trials of Bt cotton in the late eighties, but external pressure convinced the government to ask scientists to restudy their research, which led to cessation of further work. "We missed a chance to try Bt cotton, and it happened again with GM papaya years later when the government, again due to mounting opposition from civil society groups, released an executive order prohibiting the planting of GM crops unless it is for research purposes only," Dr. Sriwatanapongse reminisces. "That was 10 years of rigorous research that was ripe for commercialization." It did not help that BIOTEC decided to take a neutral stance in all of these controversies.

> **"China and India are exporting Bt cotton while the Philippines has attained self-sufficiency in corn production. Why can't we do the same?**

"Farmers continue to ask why they cannot plant GM papaya," Dr. Sriwatanapongse shares. "We feel for them but we are helpless." Green papaya salad, locally known as *som tam*, is a popular dish in Thai homes, which explains why 90% of total papaya production is consumed domestically. The rest is exported mostly as canned fruit cocktail, making Thailand the world's 12th largest producer. But the papaya ringspot virus (PRSV), which has affected production first in northeastern Thailand in 1975 and has since spread to other parts of the country, looms as a dreaded enemy.

Illegal Planting of GM Crops

Having seen how GM papaya is able to resist PRSV, which is a dreaded pest, farmers cannot understand why a better alternative to the conventional variety cannot be grown. Dr. Sriwatanapongse opines that "Thailand heavily uses chemical insecticides and is imported in great amounts. But even pesticides cannot completely solve the problem. Biotechnology is one way to cope with the predicament and at the same time conserve the environment. If there is a better way, let us use it." Dr. Sriwatanapongse shakes his head, noting that "illegal planting of GM papaya and Bt cotton (estimated at 80% of total production) has been observed in farmers' fields. There is a real need for better alternatives but, unfortunately, these have not been approved for cultivation."

Dr. Sriwatanapongse has the gait and energy of one much younger than his age. His optimism and dedication are contagious and inspiring. "We are relying on the power of the science community to get our message across to legislators. I believe that collective action and commitment can move mountains," he says. This time the science community in Thailand wants its voice heard.

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Emiliana N. Bernardo

- Professor of entomology, University of the Philippines Los Baños (UPLB) and Visayas State College of Agriculture (Philippines)
- Member, Department of Agriculture's Scientific and Technical Review Panel
- Member, Institutional Biosafety Committee of UPLB

> **"Whenever I explain crop biotechnology to people, whether they are for or against it, I entertain all kinds of questions. Questions are important, in whatever form, because they demand that scientists be cautious and critical. We (scientists) have to make sure that everything has a scientific basis."**

An Advocate of Environmental Stewardship

Ma. Monina Cecilia A. Villena

She is passionate about insects, and that is the world she has chosen to explore. Dr. Emiliana N. Bernardo is one of the most renowned entomologists in the Philippines. She belongs to the country's roster of multi-awarded scientists as attested by the numerous recognitions she has received for her notable research. Her expertise in entomology cover pest management, risk assessment, and host plant resistance to insect pests. She is currently a member of the Philippine Department of Agriculture's (DA) Scientific and Technical Review Panel, which assesses the safety of genetically modified (GM) crops. Dr. Bernardo is likewise a member of the Institutional Biosafety Committee of the University of the Philippines Los Baños (UPLB) for the multi-location field trial of Bt eggplant of the university.

For the commercialization of Bt corn in the Philippines, Dr. Bernardo leads the DA's Insect Resistant Management Advisory Team. This group of scientists looks out for signs of development of corn borer resistance to Bt corn and helps in the formulation and enforcement of insect resistance management strategies for GM insect-resistant crop varieties. The team also assists in environmental risk assessment for GM crops.

Dr. Bernardo's formal introduction to entomology started when she worked as a student assistant at the UPLB Department of Entomology tasked to *simply take care of insect cultures*. When she finished her BS in Agriculture degree, she taught at the Department of Entomology. During her long stint at the university, apart from teaching entomology, she later served as vice chancellor for instruction/academic affairs. Dr. Bernardo also taught at the Visayas State College of Agriculture (VISCA) in Baybay, Leyte (now Visayas State University). Some of her other appointments at VISCA included her being tapped as director of instruction and director of the Philippine Root Crop Research and Training Center.

In 1958, Dr. Bernardo received a scholarship grant from the International Cooperation Administration-National Economic Council for an MS degree in entomology. She was also given the Rockefeller Foundation Fellowship Grant in 1965 to pursue studies leading to a PhD degree major in host plant resistance to insect pests. She completed both her masters and doctorate degrees in entomology at Kansas State University in the United States.

> **"Entomologists help take care of the environment. And one way of doing that is by minimizing the heavy use of pesticides. I'm not saying we should not use pesticides, no. There are cases when pesticides are absolutely necessary. But, when there are other safer alternatives, why not explore them?"**

Involvement in Biotech

When asked how she got involved in crop biotechnology, she says, "It may be because of my field of specialization, which is host plant resistance to insect pests. I got involved in crop biotechnology because when Bt corn came into the picture, I was one of the senior entomologists in UPLB at that time. I was fortunate enough to have been trained under the guidance of the well-known researcher and professor in entomology in the United States, Dr. R.H. Painter of Kansas

State University." Dr. Painter is the author of the classic 1951 book *Insect Resistance to Crop Plants*, which is said to be the first textbook on host plant resistance to insect pests.

Dr. Bernardo cites her involvement in the assessment of Bt corn in the Philippines as her most notable contribution to crop biotechnology in the country. She states, "I'm so happy I became a member of the team that assessed the suitability of Bt corn in the Philippines because it was the first GM crop to be introduced here. During that time, it sparked a lot of interest among the various stakeholders." She reminisced that a lot of people then were wondering why the Philippines, a small country as compared with its neighbors in Asia, was the first to adopt GM technology. She prides herself in being one of the technical evaluators and advocates of the technology in the country, which, for the past many years, have benefited and improved financially the lives of numerous corn farmers.

> **"The very basic question that we should ask ourselves is, which is safer, the present practice or the alternative: the Bt eggplant that is rigorously evaluated by experts or unharvested eggplant fruits bathed and dipped in chemicals, which would end up in our dinner tables?"**

Fourteen years after her retirement, Dr. Bernardo remains a tireless advocate of GM crop acceptance. She was involved with Bt corn then; now she is hell-bent on pushing for the commercialization of Bt eggplant. Says Dr. Bernardo, "The current methods used by some eggplant growers in controlling the eggplant fruit and shoot borer (EFSB) are unacceptable. Many eggplant farmers spray chemical insecticides every other day or up to 80 times per growing season to control EFSB infestation in their farms. The practice is unacceptable and unhealthy to consumers, farmers, and the environment."

Insecticide Exposure

Dr. Bernardo adds, "Farmers, consumers, the environment — all these can be adversely affected by chemical insecticides if not properly selected, applied and managed. We have to be practical." She likewise cited studies conducted in major eggplant-producing provinces in the Philippines, which found that almost all farmers use chemical insecticides. Some even dip the unharvested eggplant fruits in a mixture of insecticides just to ensure that harvests are free from EFSB damage, thus marketable. "The insecticide exposure of our farmers and environment is too much," Dr. Bernardo points out.

"Entomologists help take care of the environment. And one way of doing that is by minimizing the heavy use of pesticides. I'm not saying we should not use pesticides, no. There are cases when pesticides are absolutely necessary. But, when there are other safer alternatives, why not explore them?," the lady scientist explains.

"The very basic question that we should ask ourselves is, which is safer, the present practice or the alternative: the Bt eggplant that is rigorously evaluated by experts or unharvested eggplant fruits bathed and dipped in chemicals, which would end up in our dinner tables?" she asks. Dr. Bernardo explains that Bt is very natural. "Cooking Bt eggplant or Bt corn can completely denature the Bt protein. It is not detectable in any cooked food and is therefore safe for human consumption," she said. "Moreover, we do not have the needed receptors for Bt toxin in our digestive system."

Safety Assurance

Despite the never-ending debate and opposition from other groups on the acceptance of GMOs, Dr. Bernardo believes that what is important is that farmers understand the science, and consumers are assured that government-approved GM crops

are safe. “Whenever I explain crop biotechnology to people, whether they are for or against it, I entertain all kinds of questions. I never get tired of answering them. Questions are important, in whatever form, because they demand that scientists be cautious and critical. We (scientists) have to make sure that everything has scientific basis.”

Agus Pakpahan

- Chairman of Biosafety Commission of Genetic Engineering Products (Indonesia)
- Founder of Max Havelaar Foundation

> To achieve food security, better environmental quality, energy sufficiency, as well as improved farmers' welfare, we need some support, such as biotechnology.

Strengthen Policies for Biotechnology in Indonesia

Dewi Suryani Oktavia and Heryanto Lingga

Dr. Agus Pakpahan, chairman of Indonesia's Biosafety Commission of Genetic Engineering Products, remembers his first foray into biotechnology when he served as director general of Plantation in 1998. At that time, he saw biotechnology as a new tool that could provide an opportunity for Indonesia, particularly the use of genetically modified (GM) cotton. Cotton and rice have an ideological importance in the country. Both crop symbols are on the lower left quarter of the national emblem of Indonesia, representing the fifth *Pancasila* principle, "Social Justice for the Entire People of Indonesia." Rice and cotton represent sustenance and livelihood.

Focus on Cotton

Almost 99% of clothing requirement in Indonesia is satisfied by cotton. Domestic demand for the fiber cannot be met and importation becomes necessary, thus the need to focus on production. However, the experience to develop conventional cotton through IKR (*Intensifikasi Kapas Rakyat*) failed because cotton seeds were not resistant to *Heliothis* sp., the cotton bollworm.

At that time, the United States, China, and India were planting transgenic cotton seeds (called Bt cotton) which is resistant to the cotton bollworm. Indonesia wanted to follow suit, intending to gradually adopt transgenic cotton seeds after confined field trials in Bantaeng, Bulukuma and Jeneponto, South Sulawesi in 2002. The trials showed good results, but unfortunately, many issues regarding transgenic cotton plants arose.

"I now see the differences from the perspective of change and current development of the technology," says Dr. Pakpahan. Unfortunately, discussions on the pros and cons forced the government to suspend the use of transgenic cotton. "If, at that time, there was courage from all parties to accept the presence of transgenic cotton, Indonesia might have been able to follow India's success. In Mahatma Gandhi's country, transgenic cotton has been planted in 3.5 million ha in 2002; now it has reached 11 million ha. It means an additional 1 million ha of transgenic cotton field every year in India."

> "Government policy should be clear and focused, and it should encourage through incentives, farmers and agricultural companies to use biotechnology efficiently and wisely."

Since the moratorium on growing transgenic cotton plants, the agricultural sector in Indonesia has not been involved with GM products. Biotech in Indonesia is still limited only for consumption and for research. Dr. Pakpahan says that the main constraint to adoption of biotech is the low priority given to it. He says, "The U.S. policy puts biotech as a priority after information technology. Likewise, the U.S. business world has entered a very dynamic and sophisticated environment in order to invest in biotech and agricultural support system as a whole. Thus, its agricultural productivity, within 40 years, has increased ten-fold. It means that a ton of corn, for instance, can now be obtained from one-tenth area of land compared with 40 years ago."

"Government policy should be clear and focused, and it should encourage through incentives, farmers and agricultural companies to use biotechnology efficiently and wisely," says Dr. Pakpahan who obtained his graduate degree

from the Department of Agricultural Economics at Michigan State University.

Biotechnology will develop in Indonesia if the agricultural and agricultural processing industries also grow. "Hence, it is very important to develop these industries. Meanwhile, from an internal agricultural point of view, the most important thing is to increase the land area for farmers. Agrarian reform is pivotal if we want farmers to have the ability to implement new technologies, including biotechnology," adds the man from Sumedang, West Java.

Indonesia will increasingly be confronted by the need to find new ways of producing food, feed, fiber, energy, and medicine. Biotechnology provides an opportunity for solving many problems in the agricultural field. The wide use of transgenic cotton in many countries has reduced the use of pesticides. Likewise, the presence of drought-tolerant sugarcane strain NXI-4T produced by researchers from the University of Jember (East Java) and PTPN XI in East Java points to a great potential to confer drought stress tolerance in important crops.

Impact of Transgenic Seeds

Dr. Pakpahan notes the positive and negative impacts on the environment of transgenic seed utilization, which has been done on a wide scale in many countries for the last 20 years. In particular, he cites the findings of the Research Group of the Biotech Sector of the European Union. These results show that biotechnology products can (i) reduce the use of herbicides and improve land management, (ii) reduce the use of pesticides and mycotoxin level, and (iii) increase farmers' income and health because of good yield and lower cost of production inputs.

Lately, there is a reality that can not be denied — the implementation and utilization of transgenic seed have happened very fast. After the research and development phase was completed, the first transgenic seed was legally and safely commercialized in 1996. At that time, the area devoted to biotech crops was only 1.7 million ha. In 2014, the hectarage increased to 181.5 million ha in 28 countries. The countries with the most extensive planting of biotech crops among others were the U.S. (73.1million ha, Brazil by 42.2 million ha, Argentina by 24.3 million ha, India by 11.6 million ha), Canada (11.6 million ha, and China (3.9 million ha). This fact is enough to justify that the agricultural world has experienced a new revolution, replacing the so-called Green Revolution. "With such a reality, Indonesia's attitude toward biotechnology implementation has to adopt a precautionary approach, not one based on fear," says Dr. Pakpahan, also the founder of Max Havelaar Foundation that works for the empowerment of Indonesian farmers.

> **"Biotechnology products must have satisfied food, feed, and environmental safety parameters as well as considered socioeconomic concerns, especially of farmers."**

Addressing GM Issues

Indonesia should be able to be more realistic in addressing the issue of GMO, Dr. Pakpahan suggests. Indonesia already has a set of regulations that provides legal protection for their release. The legal framework related to GMO (Cartagena Protocol) which Indonesia helped ratify in 2004 has made the country a part of the world community. In 2005, a government regulation on biosafety of GM products initiated the establishment of the Biosafety Commission of GM Products (BC-GMP). The Commission is composed of a team that takes charge of biosafety, food and feed safety, environmental safety, and serves as a biosafety clearing house. "The presence of legal, institutional, and organizational dimensions that regulate GMO is a new reality in Indonesia. The Commission works using precautionary principle,

valid scientific method, and parameters according to set guidelines," he adds.

Dr. Pakpahan concludes " We must build an institutional model that produces a win-win solution. It must be based on precautionary principle, must apply valid scientific principles, and must follow virtuous business ethics. To achieve food security, better environmental quality, energy sufficiency, as well as improved farmers' welfare, we need some support, such as biotechnology. Biotech products must have satisfied food, feed, and environmental safety parameters as well as considered socioeconomic concerns, especially of farmers."

Pornsil Patchrintanakul

- Executive at the Charoen Pokphand (CP) Company (Thailand)
- Vice Chairman of the Thai Chamber of Commerce
- President of the Thai Feed Mill Association
- Secretary of the Federation of Livestock and Aquaculture (Thailand)

> **“The use of GM crops is not the only solution but if they open a door of opportunity, why not try it? Let us not wait for a crisis to happen for the government to understand why we need to explore other alternatives.”**

Mixing Business and Science for National Development

Supat Attathom and Mariechel Navarro

As a well-known business leader in Thailand, Pornsil Patchrintanakul knows that the key to success in the business world is to see that all actors in the food value chain are able to contribute to the greater good. "One weak link in the chain will affect the smooth running of the system. Farmers are often the weakest link, they need to use modern technology. With many players in the region and the world, we cannot compete in terms of prices. It is innovation through science and technology that can give the competitive edge. It is new ideas and technologies that will add value to our products. But we need political will to make this happen."

Mr. Patchrintanakul, who has an MA degree in political economy from Chulalongkorn University, notes with trepidation that with the regional economic integration by 2015, Thailand needs to overhaul its agricultural production structure so that it can compete with other countries. The ASEAN economic community (AEC) will involve (a) a single market and production base, (b) a highly competitive economic region, (c) a region of equitable economic development, and (d) a region fully integrated into the global economy.

Competition in Animal Feed Production

He cites the example of corn which is a major ingredient in the production of animal feed. Once AEC takes effect, tariffs for export and import of corn will be zero and they will be quota-free. "The government must find ways to help corn growers cut costs to compete with neighboring countries," the businessman says. "We need modern technology to help reduce production cost per unit, improve the use of natural resources, and address issues such as climate change and carbon emission." In addition, he notes that cheaper and better quality products will benefit a broad range of consumers across different income groups.

> "The irony is that the government is not approving the commercialization of genetically modified (GM) crops in the country but what we are importing in great amounts are the very products we oppose."

The other link that needs attention is the political system. Exports in Thailand account for around 65% of its gross domestic product. While manufactured goods account for 86% of total shipments, food items such as prawns and shrimps as well as poultry products are becoming big export commodities. The country has problems in producing sufficient animal feed, particularly protein products for its animal and aquaculture feed industry. It imports a substantial amount of soybean for crushing purposes that provide the Thai feed industry with soybean meal to meet both domestic and trade quotas.

"The irony is that the government is not approving the commercialization of genetically modified (GM) crops in the country but what we are importing in great amounts are the very products we oppose," says Mr. Patchrintanakul. Wearing several hats, he is vice chairman of the Thai Chamber of Commerce, president of the Thai Feed Mill Association, and secretary of the Federation of Livestock and Aquaculture. In addition, he has a day job as a high-ranking executive at the Charoen Pokphand (CP) Company, Thailand's largest agriculture-based conglomerate.

Having studied the literature on biotechnology, Mr. Patchrintanakul understands its benefits particularly for farmers and consumers. "The use of GM crops is not the only solution, but if they open a door of opportunity, why not try it? Let us not wait for a crisis to happen for the government to understand why we need to explore other alternatives," he warns. He has been known to be very vocal about urging the government to speed up plans to expand plantations by 500,000 to 1 million rai (about 80,000 to160,000 ha) or allow planting of GM corn to ease a possible grain shortage.

> "Why do we deprive farmers and consumers with a viable choice that has been tested for safety and are less susceptible to pest infestation?"

Illegal Planting

The senior business leader also shares the view that illegal planting of GM papaya is no longer a secret in the country. Farmers know that they should not be planting the crop without government approval, but the good yield and the pest-free produce tempt them to try a variety that is resistant to a problematic pest — the papaya ringspot virus (PRSV). Already, a German exporter of Thai tropical fruit cocktail has complained about detecting GM papaya in a batch. The issue of segregation, availability, and higher cost of non-GM fruits (if available) are issues that need to be addressed. Segregation of products as GM or not will entail a system where the Ministry of Agriculture will need to certify that papaya growers are planting only non-GM crops and that farmers will have to register to comply with this requirement. For a fruit industry that actually involves a very small market (5%), are the efforts and resources commensurate to doing so?

Mr. Patchrintanakul further asks, "Are consumers willing to pay higher premium for non-GM food? Why do we deprive farmers and consumers with a viable choice that has been tested for safety and are less susceptible to pest infestation? Who can guarantee that the seeds we import such as GM soybean will not spread to plantations and also be planted illegally?"

GM papaya resistant to PRSV has long been tested for possible commercialization in Thailand. "I know about the work of scientists in Kasetsart University and how they assure the product's safety following a regulatory process. We should give this product a chance to be planted by farmers who have long voiced out the need for a variety that can assure better yields and is resistant to PRSV," the business leader adds.

> "I am convinced that we need innovation and business entities should share in the cost of research and development."

Business and Science

Committed to the interplay of business and science, Mr. Patchrintanakul sits on the executive boards of the National Center for Genetic Engineering and Biotechnology and the National Science, Technology and Innovation Policy Office, both under the Ministry of Science and Technology. As member of these boards, he shares his thoughts on science management policies, particularly the synergistic role of S & T and innovation for business. "I am convinced that we need innovation and business entities should share in the cost of research and development. Concomitantly, the government should encourage private sector participation by reducing tax incentives for innovation cost," Mr. Patchrintanakul elaborates. Sadly, however, much still has to be done to get the public and private sectors make this happen.

Time is of the essence. The clock is ticking and 2015 is now here. But Mr. Patchrintanakul thinks

that so much can still be done. "We must put our acts together and think about how the country can benefit from all these endeavors. The easy way out is to be weak and to keep quiet. But we need to make strong and clear decisions about using modern technology…before time runs out, before a crisis looms."

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Communicating the Science

Channapatna Prakash

- Professor of plant genetics, biotechnology and genomics at Tuskegee University (USA)
- Morrison-Evans Outstanding Scientist awardee
- Top 30 social influencers on biotech and biopharma (NEMUS Bioscience)

> **It is not an exaggeration to say that the 21st century is the century of biology, and biotechnology has already begun to impact so many aspects of our life — our food, our medicine, our environment, and even our law.**

Galvanizing Worldwide Support for Agri-biotech

Mariechel J. Navarro

In 2000, Dr. Channapatna Prakash spearheaded a 'Declaration in Support of Agricultural Biotechnology.' He posted the declaration online on his website www.agbioworld.org and asked members of the scientific community to sign it. The feedback was astonishing — it was signed by nearly 4,000 scientists. Twenty-five Nobel laureates, including Drs. Norman Borlaug, Paul Boyer, and James Watson, all signed the declaration.

"We, the undersigned members of the scientific community, believe that recombinant DNA techniques constitute powerful and safe means for the modification of organisms and can contribute substantially in enhancing quality of life by improving agriculture, health care, and the environment," the declaration said. It also urged policy makers to "use sound scientific principles in the regulation of products produced with recombinant DNA, and to base evaluations of those products upon the characteristics of those products, rather than on the processes used in their development."

Food Safety

The declaration likewise clarified that 'No food products, whether produced with recombinant DNA techniques or with more traditional methods, are totally without risk. The risks posed by foods are a function of the biological characteristics of those foods and the specific genes that have been used, not of the processes employed in their development." It stressed that, "Our goal as scientists is to ensure that any new foods produced from recombinant DNA are as safe or safer than foods already being consumed."

Aside from the declaration that gave agricultural biotechnology the limelight it deserved, Dr. Prakash ran an online newsletter *AgBioView*, a daily collection of news and comments on agricultural biotechnology. It generated wide interest among stakeholders as the newsletter was able to regularly gather all relevant viewpoints and developments that enabled transparent discussion and debate on the field.

The professor of plant genetics, biotechnology, and genomics at Tuskegee University, USA, continues his crusade, this time getting actively involved in enhancing awareness of food biotechnology concerns around the world. He tackles issues such as technical, societal, and ethical perspectives to a diverse audience that includes scientists, activists, and journalists.

> **"We are going to see more of biotech in our future as it has the best potential to advance humanity by enhancing our quality of life."**

Dr. Prakash has been instrumental in catalyzing the scientific community in many countries to engage in research and development on genetically modified (GM) crops. He also served on the USDA's agricultural biotechnology advisory committee and on the advisory committee for the Department of Biotechnology of the Government of India. Dr. Prakash has delivered lectures in more than 80 countries and at diverse locations such as the Vatican, the U.S. Congress, United Nations, Food and Agriculture Organization, Aspen Ideas Festival, and hundreds of universities across the world.

"It is not an exaggeration to say that the 21st century is the century of biology, and biotechnology has already begun to impact so many aspects of our life — our food, our medicine,

our environment, and even our law. We are going to see more of biotech in our future as it has the best potential to advance humanity by enhancing our quality of life. Biotech has transformed the way we farm, the foods that we consume, and of course, the medicine that we take. Its impact is widely documented in enhancing our farm productivity, reducing the usage of insecticides, increasing farming efficiency, and reducing tillage through herbicide-tolerant crops," Prakash elaborates.

Research Interests

As a researcher, Dr. Prakash's interests include studies on transgenic plants, gene expression, tissue culture, and plant genomics. His group at Tuskeegee pioneered the development of transgenic sweet potato plants, identification of DNA polymorphism in peanut plants, and the development of a genetic map of cultivated peanut. They have recently enhanced the protein content of crops several-fold through genetic modification.

> **"Biotechnology is a logical extension of many tools we have used over a few millenia to shape our crops and livestock, but with more precision, knowledge and power."**

"Wider adoption of molecular breeding tools, including GM and genomics, in agricultural research can foster greater food security and stability in the face of volatile climate changes, especially in the developing world. Agricultural biotechnology is already helping to develop novel crop varieties with improved attributes such as insect resistance and herbicide tolerance," says Dr. Prakash.

Future Benefits

In addition, the professor notes, "Potential future benefits include hardier crops tailored to tolerate climate changes including drought; smaller environmental footprint of farming (through reduced consumption of pesticides, fertilizers, and fuel); mitigating global warming through reduced emission of greenhouse gases; conserving biodiversity through reduced expansion of land for farming; nutritionally enhanced foods with added vitamins, antioxidants, protein quality and content; better foods with improved flavor, enhanced taste, and longer shelf life; developing hypoallergenic foods; making food more affordable; and developing greener energy alternatives."

Dr. Prakash recalls that he got into biotech almost by accident. "I was invited to attend a Student Pugwash conference on science and technology at Princeton University during June 1985 while I was completing my PhD at the Australian National University. I had to choose a section within this conference to participate in the discussion and prepare a paper. I chose the one on genetic engineering because it was already emerging as a hot area at that time and my background was in plant breeding and genetics. Later, when I came to the U.S. as a postdoctoral researcher at the University of Kentucky, I sat in many courses in molecular biology to learn more about biotech."

His interest in biotechnology paid off. As an awardee of the Morrison-Evans Outstanding Scientist Award by the Association of 1890 Research Directors, he was recognized for his lifetime contribution to agricultural research among the 1890 land grant universities in the U.S. He has also been honored by the Council for Biotechnology Information and the journal *Nature* as among the most influential biotechnologists. He was among a select group of scientists who was invited to speak at the Vatican in November 2013, and had an audience with Pope Francis. He, thus, walks the talk.

Social Networking

Dr. Prakash continues to engage and inform a global audience of more than 3,000 followers now on social networks. He can be found on Facebook at https://www.facebook.com/agbioworld and on Twitter at https://twitter.com/AgBioWorld. He was identified as one of the top 30 social influencers who have the largest digital and social presence and the most influence in the fields of biotechnology and biopharma. The agency Evolve was commissioned by the biopharmaceutical company NEMUS Bioscience to research top social influencers and out of 400 candidates, whittled down the number to 30.

"Biotechnology is a logical extension of many tools we have used over a few millenia to shape our crops and livestock, but with more precision, knowledge and power. I believe in biotech because I have been on the front row watching it develop in the past three decades and thus know it intimately to how it has evolved. I believe that it is the best bet to help ensure a better future for our children and their children," Dr. Prakash concludes.

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Chris Kakunta

- Development Journalist at the National Agricultural Information Services (Zambia)

> **As someone who has seen GMO crops in the lab and on the farms and who has witnessed the benefits accruing to farmers, I would say that the media, the industry to which I belong to, must work extra hard so that every farmer hears the facts and makes the right decision.**

Media will Make or Break the Use of Biotechnology in Africa

Margaret Karembu, Faith Nguthi, and Brigitte Bitta

We invite them into our houses every day. We watch and listen to them, allowing them to influence our opinion on certain issues. In turn, they influence our attitude toward the said issue, and consequently, our behavior for or against the issue. In fact, Maxwell McCombs (internationally recognized for his research on how media influences public attention) writes that media appears to "not only tell us what to think, it also tells us how to think about it." [1] He also cites media's s ability to influence what we consider as important, as well as its key role in influencing decisions that we make [2].

That is the influence that the media yields over society. Mr. Chris Kakunta, a development journalist working for the National Agricultural Information Services (NAIS) in Zambia, thinks this influence produces an outcome that has a crippling effect on the adoption of agricultural biotechnology in Africa and in his country, in particular.

Take the case of the drought that affected Zambia in 2001-2002. In early 2002, Zambia was cited as facing an "extremely tight" food situation. There was no grain in storage, maize meal prices were at an all-time high, and there were hungry people everywhere. The government declared a state of emergency [3]. With nearly 30% of Zambia's 10.2 million people facing starvation, the government (then led by President Levy Mwanawasa) had to choose whether to take or reject relief food from the World Food Programme. As fate would have it, they rejected simply because the offer included genetically modified (GM) maize.[4]

According to Mr. Kakunta, this may well have been the time that the battle lines were drawn against agri-biotechnology in Zambia. He recalls that the government "bowed" to concerns about potential risks of GM foods and refused to accept the GM grain. President Mwanawasa repeatedly said that, until he had sufficient and credible information to the contrary, he would not risk feeding Zambians with a "poison that could have long-term effects." He was more so concerned with how the media covered the story.

Media Coverage

A survey of the media coverage relating to GM crops in five developing countries, including Zambia, showed that news stories covered during the GMO debate lacked a critical analysis of issues at stake, and these rarely represented the views of farmers. The average media had to follow what the government had said, with most papers uninterested in investigating and researching on whether what was said by politicians were true. Although he could not influence all media, Mr. Kakunta immediately vowed to personally take the issue head-on and find out the truth. To his dismay, a lot of what the media had covered was based on personal opinions and long-ago myths. He now produces more balanced stories, covering agri-biotechnology issues from all views.

He believes that the major concerns emerging in most cases is whether GM technology would work in Africa and whether the western world is sincere with its intention. He also thinks that most people lack the evidence showing that the technology can work and is working on African soil. This is why, in 2012, he quickly grabbed the opportunity to visit Burkina Faso, joining a study tour organized by the International Service for the Acquisition of Agri-biotechnology Applications (ISAAA). The tour, dubbed "Seeing is Believing", comprised a delegation from seven African countries representing eastern Africa (Ethiopia, Kenya, northern Sudan, and Uganda) and Southern

Africa (Malawi, Zambia, and Zimbabwe). The delegation, made up of farmers, researchers, legislators, ginners, journalists, and biosafety regulators, visited Bt cotton fields in the western part of Burkina Faso, in the regions of Houndé and Bobo-Dioulasso, which are major cotton production zones. Its objective was tied to ISAAA's key role in knowledge sharing, "making available science-based, authoritative information to the global community." [5]

> **Burkina Faso remains an amazing country admirable in its desire to embrace science, without fear.**

Burkina Faso is the second country in Africa, after South Africa, to have successfully tested, adopted and commercialized the growing of GM crops. In 2014, the country planted 547,124 ha of biotech cotton, approximately 68.6% of all cotton grown in the country. In 2013, the industry raked in US$37 million. [6] Burkina Faso's cotton industry stands as a beacon, visible to any African country willing to follow suit.

Study Tour

Of the study tour experience, Mr. Kakunta says, "We have written a lot of articles regarding GM crops but really, to touch a GM plant is something else, and to see the crop being grown on the ground is something that adds so much value." The study tour is indeed a game-changer because since then, he has become a firm believer in the benefits of GM technology.

"The farmers we talked to were articulate in explaining the benefits of Bt cotton. I equally observed that the development of the cotton industry also had some co-benefits on the entire cropping system. Burkina Faso's National Cotton Company, La Société Burkinabè des Fibres Textiles (SOFITEX), arranges credit facilities for farmers with local banks who charge reasonable interest rates on farm inputs such as work oxen and ox-cart; farmers were also given cash advances for harvesting. The banks find this arrangement appropriate with SOFITEX as back-up and they are able to recoup their monies without difficulty. Amidst strong anti-GMO sentiments, government provided support through research and extension. Burkina Faso remains an amazing country admirable in its desire to embrace science, without fear," adds Mr. Kakunta.

> **We have written a lot of articles regarding GM crops but really, to touch a GM plant is something else, and to see the crop being grown on the ground is something that adds so much value.**

At a Common Market for Eastern and Southern Africa (COMESA) meeting in Lusaka in 2014, Mr. Kakunta brought to the attention of the COMESA secretariat the demand of the Cotton Growers Association of Zambia for their government to facilitate the growing of Bt cotton, arguing that Zambian cotton was no longer competitive in the international market because of higher production cost. His greatest concern now is whether Zambia and other African countries will embrace biotechnology and GM crops in particular. He asks, "Will the opportunity bypass them just like the Green Revolution did?"

Media's Influence

"As someone who has seen GMO crops in the lab and on the farms and who has witnessed the benefits accruing to farmers, I would say that the media, the industry to which I belong, must work extra hard so that every farmer hears the facts and makes the right decision. There is no doubt that mass media today wields a more enormous influence over the daily lives of the people than before. As Donald Ferguson noted, while the media does not mold men's minds in the fashion once suspected, they do provide the information upon which persons in a democratic society can base their decisions, both in the polling place and the

market place. It is essential that this information be as pure and untainted as human beings can make it. If the press errs, then the whole of society lives with the same mistake," Mr. Kakunta concludes.

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Jon Entine

- Founding Director of the Genetic Literacy Project
- Senior Fellow at the World Food Center's Institute for Food and Agricultural Literacy at the University of California-Davis (USA)
- Senior Fellow at the Center for Health and Risk Communication at George Mason University (USA)

> **We have no choice but to embrace innovation. Literally. The science is robust and checks and balances are in place. We are already seeing significant benefits.**

Demystifying Genetics and Biotechnology

Mariechel J. Navarro

"The greatest challenge as this century progresses will be those posed by population growth and affluence, and the strains they will put on Earth's limited resources. In the next 50 years alone, we will add the equivalent in population of two Chinas. Yet, all of the most productive farmland is already being utilized. What can we, in the developed world, do to meet this challenge? Agricultural technology, and to a large degree, biotechnology, are our only hope. We could face a perilous future if we strangulate biotechnology advances because of misplaced fears."

Mr. Jon Entine, founding director of the Genetic Literacy Project (GLP), senior fellow at the World Food Center's Institute for Food and Agricultural Literacy at the University of California-Davis, and senior fellow at the Center for Health and Risk Communication at George Mason University, sees the potential for biotechnology. "There is no other word but revolutionary—at least the potential for being revolutionary. Facing ecological and demographic challenges, biotechnology offers the prospect of increasing farm yields while limiting environmental consequences. Some of that potential has been realized, dramatically decreasing toxins in the environment and improving yields." Yet, he cautions, "Only fear can prevent further advance."

As a "science journalist dedicated to analyzing the politization of biotechnology," how did he get into the field?

"I'm a long-time journalist, having spent the first 20 years of my career as a television writer and producer for NBC News and ABC News. In 1989, NBC's Tom Brokaw and I produced a documentary for NBC on the role of genetics on sports performance, focusing on the outsized success of African-descended athletes. It led to a best-selling book published in 2000, *Why Black Athletes Dominate Sports and Why We're Afraid to Talk About It*. That ultimately led to another book on population genetics, *Abraham's Children: Race, Identity and the DNA of the Chosen People*."

"The reaction to both books was fascinating but discouraging in some ways; many people are afraid of developing technologies, including those that unlock the mystery of evolution and disease. Although the parallels are not exact, the resistance to appreciating the revolutionary discoveries in human genetics was echoed in the agricultural field. I decided to devote my research going forward to helping the public demystify genetics and biotechnology. It eventually led to my founding of the Genetic Literacy Project (GLP) in 2011, which addresses the nexus of genetics and biotechnology with media and public policy," Mr. Entine explains.

> **"The United States has been built on risk taking. Biotechnological research is cutting edge — it challenges paradigms."**

Commitment to Science

Mr. Entine adds, "I have witnessed an explosion of misinformation and disinformation in the media and in policy debates about genetic innovation—human and agricultural. We now offer daily access to the best journalism, blogging and research on medical and human genetics, drug biotechnology, and agricultural biotech and food. There are no 'sacred cows' for the GLP; our only commitment is to the science. The GLP also offers an annual Biotech Bootcamp to train scientists how to more impactfully convey the science of biotechnology,

hopefully containing the explosion of anti-science that is so prevalent in cyberspace and across so many media channels." GLP's tagline is "Where science trumps ideology."

Mr. Entine, who received his degree in philosophy from Trinity College and studied at the University of Michigan under a National Endowment for the Humanities Fellowship, further explains his views on biotechnology. "The United States has been built on risk taking. Biotechnological research is cutting edge—it challenges paradigms. There is no question that this country will continue to take a leadership position in biotechnology in the years ahead. That said, there is a discouraging technophobia that has arisen in the U.S., and sadly it's perceived as "progressive" when it is exactly the opposite. Those precautionary obsessions are even more prevalent in Europe and elsewhere. I'm cautiously optimistic that the exaggerated fears promoted by non-government organizations (NGOs) resistant to biotechnology will not prevail, but it is gumming up the regulatory structure, making it challenging to introduce innovations."

"I'm cautiously optimistic that the exaggerated fears promoted by non-government organizations (NGOs) resistant to biotechnology will not prevail, but it is gumming up the regulatory structure, making it challenging to introduce innovations."

Also a visiting fellow at the American Enterprise Institute since 2003 where he focuses on science and public policy, Mr. Entine reiterates the critical role that biotechnology could and should play in the years ahead: "We have no choice but to embrace innovation. Literally. The science is robust and checks and balances are in place. We are already seeing significant benefits."

Politics and Trade Disputes

In his book *Let Them Eat Precaution: How Politics is Undermining the Genetic Revolution in Agriculture* published in 2006 that Mr. Entine edited and contributed to, experts from the U.S. and Great Britain explain why cultural politics and trade disputes, not science, pose the biggest hurdles in developing products. It notes that well-funded environmental groups, organic advocates, and religious groups among others exploit anxiety about science. The authors suggest that biotechnology proponents must address political, social, moral, and economic issues raised by critics instead of merely relying on scientific evidence.

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Jia Hepeng

- Science communicator (China)
- Former Editor-in-Chief of *Science News Magazine* affiliated with the Chinese Academy of Sciences
- Former Executive Director of the World Federation of Science Journalists

“I think the next-generation agri-biotechnology will play even a bigger role in the sustainable development of our society amidst various challenges, among them climate change and swelling global population, which are particularly important to China.”

Good Journalists Never Stop Revealing the Truth

Tian Zhang

As one of the most prominent science journalists in China, Mr. Jia Hepeng had an early interest in agricultural biotechnology. "As an active journalist, I had an instinctive interest in and a deep concern about it. It was a hot topic and a controversial one and I wanted to protect public interest by exposing 'bad science' like agri-biotechnology," Mr. Jia says.

A former editor-in-chief of *Science News* magazine in China which is affiliated with the Chinese Academy of Sciences (CAS), Mr. Jia did extensive research and investigation on the topic. It was the evidence that changed his attitude toward the technology.

Interest in Biotech

"I remembered my interview with Professor Zhu Zhen, former deputy director of the Institute of Genetics and Developmental Biology, CAS, in early 2003. Zhu patiently explained every point raised by critics against agri-biotechnology and clarified nearly every concern I had. Another force to cause my shift was the chance for me to freelance for international science media, primarily the London-based *SciDev.Net* and *Nature Biotechnology*. During the freelancing process, I came to know of a few acceptable papers to prove the 'harm' of agri-biotechnology. My experience with the top international journals provided me the norm to base every claim of my reporting on solid evidence, but it was Prof. Zhu's candidness and clarity that made me trust scientists," he explains.

Mr. Jia's earlier work on agri-biotechnology mainly relied in his role as a science journalist and a science communication practitioner. He initiated and organized many communication-related events, including organizing one of China's earliest agri-biotechnology communication symposia, developing the first website on agri-biotechnology dialogue, and publishing a media handbook on agri-biotechnology in Chinese. He has been involved in drafting the communication section of a formal CAS scientific report on agri-biotechnology, which was submitted to top Chinese leaders. The central task surrounding these projects is to make people, particularly those in the communication process, to base their claims and judgment of agri-biotechnology on acceptable evidence. "As a science communicator, my role is to promote the sustainable development of science amidst various social and public concerns, at least to smoothen the increasing tension between fast-growing science and technology and the rising social uneasiness towards it," Mr. Jia says. In 2010, he won the honorary title "National Advanced Worker for Science Communication" awarded jointly by China's Ministry of Science and Technology, Propaganda Department of the Central Committee of the Communist Party of China, and China Association for Science and Technology.

Currently, Mr. Jia is pursuing his PhD in communication at Cornell University. As part of his academic work, he has been extensively studying and writing about public opinion on agri-biotechnology (as an example of scientific controversies). He is identifying and summarizing the key elements underneath people's resistance to agri-biotechnology.

"For my ongoing research on agri-biotechnology communication, I am focused on revealing the social, political, and psychological factors that predict people's attitude to agri-biotechnology. I have made a comprehensive literature review on previous research on the topic and the results of this research were published as several papers. But, most of the research is made in the developed countries, while China, as a transitional economy,

may have quite different factors to explain the public attitude to the technology. I am trying to identify these factors," Mr. Jia adds.

A former executive director of the World Federation of Science Journalists and director of Science and Development Network in China, Mr. Jia is also a team member of the risk communication section of the National Key Research Program on Agri-biotechnology. He continues to freelance in China as a columnist, writing about genetic modification (GM) issues and concerns. While not as active as he was once as a journalist, Mr. Jia is disseminating mainstream scientific views on recent GMO developments. These include the widely refuted French study on GM maize's carcinogenicity and the referendum on GMO labeling in the US states of California and Washington, which he tackles in his columns and articles to encourage evidence-based rationality among Chinese readers.

> **"We will have much more evidence to understand the mechanism underlying people's attitude to GMO and thus we will be able to promote its acceptance by strengthening those positive factors."**

Future for Biotech

Now, Mr. Jia is a believer of biotechnology. His confidence comes not only from its power to create benefits for people but also from his conviction that, with progress in science communication, "biotechnologies in general and agri-biotechnology in particular will have a brilliant future in this world and in China." He notes, "It is one of the key forces to promote food security, social progress, and economic prosperity in the world. I think the next-generation agri-biotechnology will play an even bigger role in the sustainable development of our society amidst various challenges, among them climate change and swelling global population, which are particularly important to China as the world's most populous nation. We will have much more evidence to understand the mechanism underlying people's attitude to GMO and thus we will be able to promote its acceptance by strengthening those positive factors."

Making Benefits Available

"Traditionally, the influence or powerfulness of a new technology is embodied through the presentation of its benefits to the people," Mr. Jia adds. "But agri-biotechnology has to be different. Its primary benefits must accrue to farmers, who are either politically weak or demographically marginal. Substantial efforts should be made to embody its benefits to consumers, particularly poor people. Therefore, Golden Rice, with its potential benefit to improve nutritional deficiency, should be made available to the poor people as quickly as possible. It is the most persuasive way for people to accept GMO, at least morally. "

"There has been a strong legacy of GMO resistance, so that many people have equated GMO resistance to environmental protection or to protesting against capitalism. Hype surrounding such a highly controversial product as GMO should always be avoided because any unmet promise could be disastrous. The world's leading charity groups, such as the Bill and Melinda Gates Foundation, should support research and development of biotech products like Golden Rice and the promotion of these products. It is crucial to have an early example of a crop that benefits people as a whole, rather than just big farmers who can afford expensive agri-biotechnological seeds and related herbicides," Mr. Jia explains.

But agri-biotechnology has to be different. Its primary benefits must accrue to farmers, who are either politically weak or demographically marginal.

Evidence-based Reporting

Rational attitude and evidence-based reporting should always be the right attitude of journalists (whose composition has been expanded to citizen media workers who use blogs and other social media to report events) in dealing with any controversial topic, including GMO. To Mr. Jia's mind, a good journalist shall not avoid challenges and problems linked to technology.

A good journalist should never stop at revealing these problems. "He or she must ask 'why'? And all the 'whys' should be based on solid and authoritative evidence. In the same vein, a good journalist should also avoid hyping the sensational aspects of GMO. Many communication studies have indicated that the audiences are not reasonable enough. They would not take all knowledge seriously. This is human nature. So, do not think that you can make big sensational news and then balance the negative side by making thorough and clarified explanation. Never! Readers simply remember the 'bad' event and then go away. You, as a responsible journalist, will have no chance to clarify certain issues with your readers."

> **"He or she must ask 'why'? And all the 'whys' should be based on solid and authoritative evidence."**

Mr. Jia's career goal is to combine academic research on GMO communication and a practitioner's role in risk communication. The most ideal position for the task is a professorship of communication at a top Chinese university. "But that is not the goal, it is only a means. I do believe more and more studies on communication regarding agricultural biotechnology — including those done by me —will help us develop more effective communication strategies based on solid evidence and reasonable application."

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Bruce Chassy

- Professor of University of Illinois at Urbana Champaign (USA)
- Author, *History and Future of GMOs in Food and Agriculture, Crop Biotechnology and the Future of Food: A Scientific Assessment*, and *GMOs: A Plateful of Promises*
- Maintains GM food safety website at http://academicsreviews.org

“In the future, we can expect to see crops with improved nutrition and other desirable traits, crops that will cope with climate changes, will be intrinsically more productive, and which will make more efficient use of resources. The impact on agriculture has been phenomenally positive and beneficial.”

Getting the Message Out and Clear

Mariechel J. Navarro

Scientists are expected to do more than disseminate information in their field of interest. They are also encouraged to participate in the debate and discourse on science and technology. But not many scientists are willing to venture beyond the laboratory and be actively part of the conversations and narratives that occur in the public sphere. Several reasons are forwarded: inadequate communication skills, difficulty in popularizing technical jargon, and lack of audience interest. Yet, studies show that university professors and public sector scientists are regarded by stakeholders as highly credible, trustworthy, and key information sources. They need to be part of the debate so that uncertainties, doubts, and fears about technology can be explained.

Dr. Bruce Chassy is one of those who have created a balance as a scientist and as a science communicator. As a professor and researcher at the University of Illinois at Urbana Champaign, he worked on the characterization and development of methods for the genetic manipulation of microorganisms used in food and dairy fermentation. His interest spans food safety and the safety evaluation of biotech foods.

Public Engagement

He has also found the time to explain the science of biotech and the controversy surrounding it to various stakeholders. He maintains a website (http://academicsreview.org) where he reviews claims about GM food safety. *Academics Review* stands against "falsehoods, half-baked assertions, and theories or claims not subjected to rigorous review." In addition, he speaks at national and international meetings and is often a guest on television and radio programs in addition to writing articles and blogs for several mainstream and online publications. In addition, he has authored papers on *The History and Future of GMOs in Food and Agriculture, Crop Biotechnology and the Future of Food: A Scientific Assessment,* and *GMOs: A Plateful of Promises.*

Early Interest in Molecular Biology

"As a student, I was fascinated by DNA, genetics, and the evolution of life on earth. I wrote several papers on the topic in high school and college. I considered several professions but probably always knew that I would be a scientist and a teacher," Dr. Chassy recalls.

"Three events stand out to me as shaping my career choice to focus on using the tools of molecular biology in my research. I can still remember the excitement that came one day in 1961 in my biochemistry class when the instructor came in and said that instead of the planned lecture we would review a new paper in the *Journal of Biological Chemistry* by Marshall Nirenberg (Nobel Prize, 1968) that reported the deciphering of the genetic code. A few years later, when I was a graduate student at Cornell, I remember Bob W. Holley (Nobel Prize, 1968) coming into the classroom for a class he taught in nucleic acids. Instead of talking, he walked to the blackboard and wrote a series of A's, U's, G's, and C's that represented the sequence of the yeast phenylalanine transfer RNA—the first nucleic acid ever sequenced. I earned a PhD in biochemistry and molecular biology from Cornell in 1966."

"In 1973, while working as a research chemist at the National Institutes of Health in Bethesda, Maryland, I read a paper by Herb Boyer and Stan Cohen in the *Proceedings of the National Academy of Sciences* (PNAS) that described the transformation of a bacterium (*E. coli*) by recombinant plasmid DNA. The transformed cells produced a new protein, ampicillinase. The ability to transfer genes from one organism to

another and thereby introduce new traits opened the way for genetic engineering and formed the foundation of what came to be known as the "biotechnology industry." I decided, at that point, to apply this newly emerging technology first to medical and dental applications and later in food and agriculture," Dr. Chassy reminisces.

Biotech Applications

His early interest in biotechnology and its applications was eventually validated over the years. "Today, more than 100 pharmaceuticals are the products of biotechnology. New vaccines are being made using the techniques of biotechnology. Genetic engineering has been applied to the production of food ingredients and chemicals. Many useful enzymes are produced using biotechnology. Biotechnology has also been applied to the production of new and better seeds that have found widespread use in agriculture. There are many other applications of this science that range from creating art to remediating environmental contaminants. The possibilities are endless. Biotechnology is simply the science of putting life to work for useful purposes. Its products surround us in our everyday lives. I think the applications of biotechnology will be with us in the future. In my area of interest, food and agriculture, applications of biotechnology will continue to expand," Dr. Chassy explains.

"Today's biotech crops have offered a host of improvements in agriculture, which include improved yields, lowered input costs, less use of chemicals, better stewardship and less labor, disease resistance, and improved sustainability. In the future, we can expect to see crops with improved nutrition and other desirable traits, crops that will cope with climate changes, will be intrinsically more productive, and will make more efficient use of resources. The impact on agriculture has been phenomenally positive and beneficial. There are many studies and papers that document the benefits of biotechnology." Ironically, Dr. Chassy notes that he "continues to be astounded that there is opposition to and criticism of biotechnology after almost 20 years of successful use on billions of hectares of farmland." The University of Illinois professor notes, however, that it would be incorrect to say the prospects are endless. "Biotechnology is just a tool that is used to introduce new desirable traits in organisms or, in some cases, modulate or remove undesirable traits. No one technology can be a magic bullet that will solve all of the world's challenges. Many other technologies and management practices will be needed to improve foods and agriculture to meet future needs. The technology is, however, exceedingly useful for engineering changes into living organisms. It is often used in combination with other technologies that are used in breeding improvements into microbes, animals, and crops. It is also important to note that some kinds of genetic changes are easier to do with other breeding methods. All of these point to the conclusion that biotechnology is a powerful tool, but it is not the only tool we will need to manage future challenges. That said, I believe that we cannot meet the food and agricultural needs of the future without biotechnology."

> **"I am not pro-biotech. I see myself as a supporter of science and technology when it is used appropriately."**

Biotech Challenges

According to Dr. Chassy, biotechnology faces two important challenges. "The first is that a small but committed group of opponents have instilled fear in consumers, policy makers, and governments. Much of what these groups say is not factually correct; often, they deliberately spread misinformation. It is not unusual for humans to be cautious and concerned about new technologies about which we know little and which we have been told are untested — in fact, it makes good sense to be careful. As a result of widespread campaigning against biotechnology in agriculture and food, many people around the world are not certain that biotechnology is either

necessary or safe. Society will need to move past this opposition in order to capture the benefits offered by biotechnology."

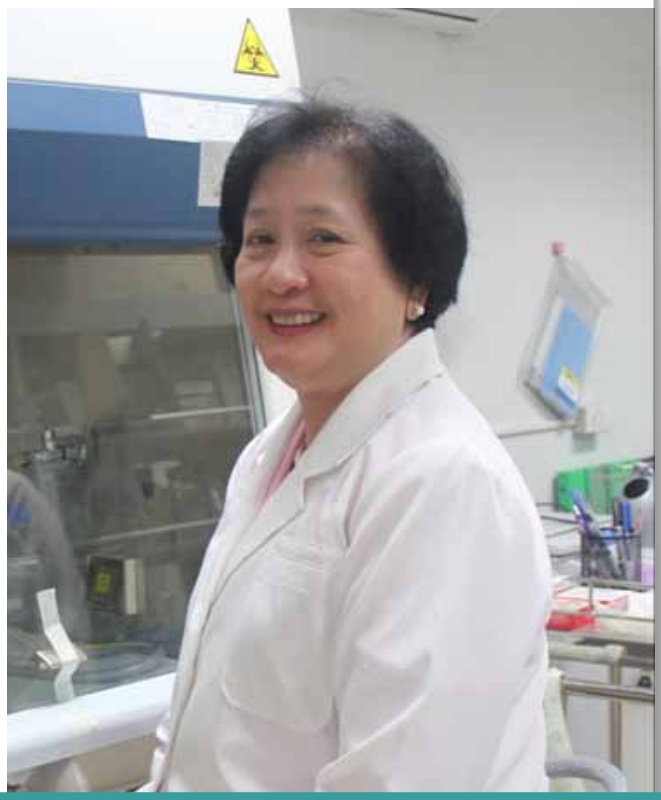
"Secondly, one consequence of the belief that biotechnology is somehow a new or different way to breed plants and animals is that governments around the world have applied strict regulations to the use of the science. It takes 5-10 years and can cost more than US$100 million to develop and gain approval for a new biotech crop. This means that few developments will come to the market and it also means that only the largest international corporations who have the needed resources will be able to introduce new products. Paradoxically, there is an overwhelming scientific consensus based on extensive scientific evidence that products produced using biotechnology are as safe as, or are safer than, products produced using other methods of breeding. From a purely scientific perspective, it makes better sense to regulate products produced by other methods of breeding or, at the very least, to regulate all new phenotypes regardless of the methods used to produce them. These unwarranted regulatory barriers need to be removed," Dr. Chassy opines.

> **"Biotechnology is a powerful tool, but it is not the only tool we will need to manage future challenges."**

Supporter of S&T

The scientist clarifies that biotech is just a scientific tool for introducing genetic changes. "It can be useful in research aimed at improving our knowledge of how living systems work, and it can help us produce better products. If products are produced that don't function correctly or which cause more harm than benefits, obviously we should not use them. I am not pro-biotech. I see myself as a supporter of science and technology when it is used appropriately. In the case of agricultural biotechnology, the benefits have been considerable and the harms have proven few and quite manageable to date. If products fail to meet that standard, I would not support their use."

To Dr. Chassy, it is a life mission to empower the public to make crucial decisions regarding acceptance and adoption of biotech but these must be based on what science has to say about it.



Nina Gloriani

- Medical researcher and doctor, University of the Philippines (UP) Manila
- President, Biotechnology Coalition of the Philippines
- Former Dean of the College of Public Health at UP Manila

> **Everything we do, everything we have, there are risks. We look at the risk, we assess the risk, and we manage the risk.**

Taking Scientific Arguments to Public Engagement

Sophia Mercado

Shifting from the stereotyped scientist in the lab to a staunch educator and advocate came smoothly for medical researcher and doctor, Nina Gloriani.

Dr. Gloriani, who conducts a limited practice of her profession in clinical microbiology aside from being an esteemed professor and former dean of the College of Public Health at the University of the Philippines Manila (UP Manila), admits that she was normally just a quiet scientist immersed in research and the laboratory before she went into the biotech debate. But, after an encounter with a biotech critic from the academe, then director of the Institute of Biotechnology and Molecular Biology at the National Institutes of Health-University of the Philippines Manila (UP Manila), Dr. Gloriani felt driven to step up from being a scientist confined in a lab, clarify the truth, and present her professional take about the claims presented against biotech products, particularly genetically modified organisms (GMO). The experience somehow served as a catalyst for Dr. Gloriani's efforts on biotech education to start rolling. Since 1999, she has been a resource person more than five times a year in various local and international speaking engagements on GMOs, human health, and food safety.

Outstanding Scientist

Her expertise and caliber in her field cannot be denied with the numerous awards she received from national scientific and academic bodies and organizations, including UP Manila's Most Outstanding Researcher in 2001, the Philippine Society for Microbiology's Outstanding Microbiologist in 2006, UP Alumni Association's Outstanding Professional in Public Health in 2006, and other citations. With a PhD in microbial immunology and immunochemistry and having completed postgraduate training and fellowships in biotechnology, clinical microbiology, HIV/AIDS immunology and virology from universities such as the University of California, Los Angeles, Georgetown University in San Francisco, and Kobe University in Japan, Dr. Gloriani was involved and has led many research projects on molecular biology and biotech, particularly vaccines, human and animal seroepidemiology, and risk assessment of biotech-derived food, among others.

> **"We are no longer the stereotypes with lab gowns, in the laboratory. More of us are out now. We explain what we are doing. We explain what the science is about, what the need is for."**

In UP Manila, she became chairman of the Department of Medical Microbiology in the College of Public Health; director of the Institute of Biotechnology and Molecular Biology; and dean of the College of Public Health. She was also the director of SEAMEO-TROPMED Regional Center for Public Health, Hospital Administration, Environmental and Occupational Health from 2007 to 2013. Now, she is working on the development of *Leptospira* vaccines applicable in the Philippine setting and a project on risk factors in the outbreak of infectious diseases and psychosocial problems in the aftermath of disasters in the national capital region and neighboring provinces.

As an active voice in the biotech arena in the Philippines, Dr. Gloriani also shares that what fueled her desire to explain were the sudden and demanding questions from anti-GMO activists. She explains the need for information and data so as to accurately answer the questions. "We need to

be very upbeat but careful in a sense that we do not become like them (anti-biotech groups). You cannot win battles that way, and it is not the truth. We just go by what is true. If there are possible side effects, then we also say those because of the risk." Still, Dr. Gloriani remains steadfast in countering anti-GMO efforts.

> **"With economic development, it is already certain that technologies will come in. There will be more products, and the public has to understand their applications and what good they will do for us."**

As the leader of the Biotechnology Coalition of the Philippines (BCP) since 2007, she acknowledges the need for continuous education for all stakeholders. BCP is a non-stock, non-profit membership association of multi-sectoral advocates from the academe, the scientific community, farmers' organizations, industries, the church, media, and other civil society organizations, "We are after those who will not use technology for good noble purposes." She also places emphasis on young students, believing that biotech education should start in the early years. "Maybe they're the best ones to teach because they don't have misconceptions and biases." Under her leadership, BCP has reached out and conducted biotech education activities all over the country, some in partnership with and involving ASEAN countries, while bringing together the various biotech stakeholders.

Dr. Gloriani also recognizes that more scientists like her are also out in the field. "We are no longer the stereotypes with lab gowns, in the laboratory. More of us are out now. We explain what we are doing. We explain what the science is about, what the need is for."

As an expert in the meticulous fields of medicine, public health, and microbial immunology and immunochemistry, Dr. Gloriani never concludes her talks and explanations on GMOs without emphasizing the nature of scientific research and risks.

Assessing and Managing Risks

"In any scientific experiment, we do not always have a hundred percent answer. That is why we keep on researching. But there is a point where we can say that this is already conclusive, based on the standards that we have set. Well, over the years, that will change, but, as I've said, there is no zero risk." She also highlights the importance of case-by-case assessment, which, she points out, is not just for biotech products, but for any new technology as well. "At some point, we already know the safety angle. We should arrive at certain conclusions, given what we do, depending on what we see… at some point, you can conclude based on very rigorous standards of your methodology which should be internationally accepted. That is why we have accreditations and certifications," she explains. "We cannot keep on saying these things that they (anti-GMOs) say," she adds, referring to safety issues posed by biotech detractors that have already been addressed globally.

During a consultative meeting of stakeholders for the Philippine position in the 7th Conference of Parties as Meeting of Parties to the Cartagena Protocol on Biosafety (COP-MOP), Dr. Gloriani puts into context the risk management in every technology. "Everything we do, everything we have, there are risks. We look at the risk, we assess the risk, and we manage the risk." She also puts forward the helpful intentions of Filipino scientists who choose to stay and serve the country, stating that they do their best in developing products that will benefit the Filipino people. "We will never put you in harm's way," she said.

Pushing for Biotech

She also distinguishes medicinal and agricultural biotechnology, understanding that it is harder to press the case for biotech in agriculture and

food. Dr. Gloriani says the public is more accepting of biotechnology as applied to medicine and health because it is "curative" and "prevent a lot of infections." "But with crops, it's about something you eat everyday, so there are some questions."

By persistently echoing the principles in her medical fields through her own efforts and BCP's various outreach activities, Dr. Gloriani helps push forward biotechnology (be it in the medical or agricultural arena), recognizing the advantages it would bring to the Filipino people. "With economic development, it is already certain that technologies will come in. There will be more products, and the public has to understand their applications and what good they will do for us."

Mark Lynas

- Visiting Fellow at Cornell University's Office of International Programs at the College of Agriculture and Life Sciences (USA)
- Author, *The God Species: Saving the Planet in the Age of Humans* and *Six Degrees: Our Future on a Hotter Planet*
- Vice-Chair of the World Economic Forum's Global Agenda Council on Emerging Technologies

"It is not enough to sit back and hope that technological innovation will solve our problems. We have to be much more activist and strategic than that. We have to ensure that technological innovation moves much more rapidly, and in the right direction for those who most need it."

Uprooting the Weeds of Misinformation

Mariechel J. Navarro

It was a school holiday in August 2013 at the University of the Philippines Los Baños. Organizers were not too sure about a captive student audience where Mr. Mark Lynas, prize-winning author and former anti-genetically modified organism (GMO) activist, was the guest speaker at a convocation. Ten minutes before the afternoon talk, the auditorium was packed with students, scientists, and academics while others had to be turned away, many of them perhaps curious to listen to what this man had to say. After all, this was the man who was among those who joined the anti-GM movement and participated in the uprooting of GM crops in field trials in the United Kingdom in the mid-1990s. Today, he is singing another tune — that of the benefits of the technology — but not after going through a process of discernment in his quest for evidence-based answers.

Anti-GM Movement

Mr. Lynas' involvement with anti-biotech groups was a phase: "I helped to start the anti-GM movement where I assisted in demonizing an important technological option which can be used to benefit the environment." He attributes the initial ferment to the idealism of youth and the exciting times for environmental activism. The anti-science campaign in Europe, which he was initially part of, proved to be a most successful one, with fears about "scientific powers being used secretly for unnatural ends" spreading to Africa and Asia. So successful was the movement that, to this day, many countries ban the use of the technology.

Riding on his interest with the environment and its issues, the journalist-writer wrote a book *Six Degrees: Our Future on a Hotter Planet* in 2008, which won the prestigious Royal Society science book prize. The book was eventually made into a film by the *National Geographic*. He followed this up with T*he God Species: Saving the Planet in the Age of Humans* in 2009. The book noted that humans are God species, being both creators and destroyers of life. It called for the use of technological mastery over nature by managing the planet successfully to continue life and civilization. In the course of doing research for a chapter in agriculture in the book, he discovered that his anti-GMO stance had no basis after reading articles in science journals.

Value of Science

"I'm not a doctor. I don't have any PhD [and] so I really have to start from the very beginning in terms of understanding scientific methodologies, appreciating the value of science as a form of knowledge as opposed to just campaigning, or assertion or argument or shouting. And on that basis, I wanted my books to be credible and to be authoritative," he explains. This awakening led him to call for the use of environment-friendly technologies such as genetic engineering and nuclear power.

Mr. Lynas, who was then a research associate at Oxford University's School of Geography and the Environment, kept this change of opinion to himself until the Oxford Farming Conference in January 2013 where he had been invited to give a talk. Without possibly realizing that he might have opened a Pandora's box of doubts and skepticism, he admitted retracting his decade-long negative position on GMO after carefully studying scientific data on which his assumptions were based.

To his audience, he posed the question: So I guess you'll be wondering— what happened between 1995 and now, that made me not only change my mind but come here and admit it? Well, the answer

is fairly simple: I discovered science, and in the process I hope I became a better environmentalist." By reading the scientific literature, he discovered that one of his "cherished beliefs about GM turned out to be little more than green urban myths." His assumption that GM would increase the use of chemicals was unfounded. Rather, pest-resistant cotton and maize needed less insecticide. Still another assumption was debunked — that GM benefited only the big companies. Instead, billions of benefits were accruing to farmers needing fewer inputs.

"It is not enough to sit back and hope that technological innovation will solve our problems. We have to be much more activist and strategic than that. We have to ensure that technological innovation moves much more rapidly, and in the right direction for those who most need it," Lynas added.

In conclusion, Mr. Lynas emphatically stresses "I don't know about you, but I've had enough. So my conclusion here today is very clear: the GM debate is over. It is finished. We no longer need to discuss whether or not it is safe — over a decade and a half with 3 trillion GM meals eaten — there has never been a single substantiated case of harm…. So my message to the anti-GM lobby, from the ranks of the British aristocrats and celebrity chefs to the US foodies to the peasant groups of India is this: You are entitled to your views. But you must know by now that they are not supported by science. We are coming to a crunch point and, for the sake of both people and the planet, now is the time for you to get out of the way and let the rest of us get on with feeding the world sustainably."

The reaction to Mr. Lynas' confession was fast, winning the admiration of some for his bravery to speak up and losing close friends who had earlier shared his thoughts on the technology. The online feedback to his talk generated 532 comments before the system stopped posting more views. He has since become a sought-after speaker in different countries, not just on biotechnology but on climate change and nuclear power.

In October 2013, Mr. Lynas was appointed a visiting fellow at Cornell University's Office of International Programs at the College of Agriculture and Life Sciences. He is also a member of the advisory board of the science advocacy group Sense About Science and is vice-chair of the World Economic Forum's Global Agenda Council on Emerging Technologies. His appointment at Cornell now allows him to pursue his interest in assisting biotech work concerned with food security and environmental sustainability. He visits projects such as Golden Rice in the Philippines, advises the Bt brinjal (eggplant) project in Bangladesh, and goes to African countries for advocacy and research work on biotech.

> **"The GM debate is over. It is finished. We no longer need to discuss whether or not it is safe — over a decade and a half with 3 trillion GM meals eaten — there has never been a single substantiated case of harm."**

Public Engagement

Mr. Lynas' website (http://www.marklynas.org/) features a wide range of topics on agriculture and the environment. On his homepage, he tackled media reports claiming that GM pest-resistant Bt brinjal has failed in the field and that farmers in Bangladesh are regretting that they have begun to grow it. "It is entirely false. I myself, along with various scientists and others from Cornell University and the Bangladesh Agricultural Research Institute, visited the same farm a day earlier and found the crop in good health and the farmer happy." He attached photos to prove otherwise.

But Mr. Lynas continues to be in the 'battlefield" of public debate. In July 2014, he spoke on climate change and biotechnology at an Argentinean university. Although used to the antics of the antis, he was surprised by a full-scale invasion of hecklers

complete with shouting, banners, and dreadlocks. He tried to engage them to raise their points but the group became aggressive. Nevertheless, he stood his ground and eventually realized how irreconcilable his worldviews and those of the activists were.

But, to Mr. Lynas, evidence fuels science and it cannot be otherwise.

Further Reading

Lecture to Oxford farming conference, 3 January 2013. http://www.marklynas.org/2013/01/lecture-to-oxford-farming-conference-3-january-2013/. Accessed August 20, 2014.

Thinking Beyond Technology

Winarno Tohir

- Chairman of the National Outstanding Farmers and Fishermen Association (Indonesia)

> **Farmers are ready to accept the latest technology, including biotech crops, as it can bring substantial benefits to farmers. I have had opportunities to be invited to several events that showcased the technology to enable me to come to this conclusion.**

Consider Ethics in Developing Transgenic Crops

Dewi Suryani Oktavia and Heryanto Lingga

Indonesia, an archipelago in Southeast Asia, is predominantly an agricultural country with 21 million farmers engaged in the industry. Perhaps, only 10% of these farmers are aware of biotech crops. This is expected, as currently, there is no biotech crop approved for commercialization. Local scientists, however, are developing genetically modified (GM) sugarcane and potato.

Nevertheless, Winarno Tohir, chairman of the National Outstanding Farmers and Fishermen Association (NOFA) in Indonesia, believes that "farmers are ready to accept the latest technology, including biotech crops, as it can bring substantial benefits to farmers. I have had opportunities to be invited to several events that showcased the technology to enable me to come to this conclusion."

Information on Biotech Crops

Winarno first heard about biotech crops in school. During a visit of the People's Representative Council in the region, students were informed of a tall and high-yielding biotech tomato. "As a son of a farmer in the village, I was amazed by that information and I have continued to seek information about this technology," says Winarno.

After graduating from high school, he heard about Golden Rice (GR), which contains beta-carotene or vitamin A precursor being studied by the International Rice Research Institute (IRRI) in the Philippines. At that time, the minister of agriculture, Mr. Syarifudin Baharsyah, introduced the concept of GR. "When is it going to be available, Mr. Minister?" asked Winarno. "It is still undergoing research at IRRI", said the Minister. Winarno admits that he did not fully understand about GM crops, particularly how it is possible to insert a specific gene into a high-yielding rice variety to improve the crop. But this information excited him. The farmer leader eventually graduated in 1990 from the Tanjung Sari Agricultural University, Sumedang, West Java.

International Exposure

In 2000, Winarno and a number of farmers from NOFA attended an international conference on agriculture in California, USA. In a round-table meeting, one of the resource speakers from the U.S. told them: "If Indonesia is ready to accept the presence of biotech crops, then we will be ready to help." In 2003, Winarno attended an agricultural meeting in Paris, France, which apparently also discussed the development of biotech crops. At that time, the U.S. representative talked about biotech crops. Later on, a reporter asked him about what Indonesian farmers felt about the technology. "As long as it can benefit us, why not?," Winarno answered.

> "As a product of the latest technology, biotech crops must also be applied within a stewardship context by assigning agricultural extension workers whom farmers could interact with and who could answer their questions about the technology."

A year later, Winarno got an opportunity to share experiences and knowledge with farmers in Gambia, Africa. During his three-month visit in Gambia, he saw wheat plants in experimental areas growing so well and lush in the middle of dry land.

He was surprised, saying "How could the crop grow in the middle of dry land with no other vegetation? A farmer told me that the wheat crops are products of biotechnology which are resistant to drought. That was the first time for me to actually see a biotech crop." The drought-resistant wheat plant was inserted with a gene obtained from a native plant called African Baobab tree, which can survive devastating droughts. Winarno wanted to bring home the seeds, but unfortunately he was not allowed to do so.

At the seeing-is-believing tour of the Philippines in 2011, Winarno got further interested about biotechnology. He witnessed various biotech applications in the country for livestock and crops.

Winarno's interaction with biotech crops continued. Between 2012 and 2013, he, along with some Indonesian farmers, biotech researchers, heads of agricultural bureaus, and the director general of the Ministry of Agriculture visited U.S. research laboratories. During the visit, he saw how gene crossing is done. Winarno was fascinated not only by the development of research in the field of genetic engineering but also by how developed countries practice precision farming. Farmers can bring soil samples to be assessed in the government laboratory facility, and they get recommendations as to the kind of crop to be planted and the type of fertilizer to use.

Problems with New Technology

Since many Indonesian farmers have finished only elementary education and rely on their ancestral and family experiences with farming, Winarno is well-aware of fundamental problems when considering technological development in agriculture. He cites the case of hybrid rice seeds as a way to increase crop productivity. "Many farmers refused to use hybrid rice seeds because there's no one to guide them on how to cultivate them." Farmers rejected hybrid rice seeds because they made mistakes in following the cultivation procedures for hybrid seed. For instance, they soaked the seeds for two to three nights instead of only 2-3 hours. Because of this, they got unsatisfactory result. Farmers were disappointed and reluctant to use the superior seeds. "Since 2000, there has been no stewardship program to guide farmers in cultivating hybrid seeds properly and correctly," the farmer leader explains.

Stewardship of Biotech Crops

The farmer leader suggests that when new technologies such as biotech crops are introduced in the future, adequate briefing should be provided. "In addition, there should be a guide book on proper cultural recommendations, such as the one that accompanies electronic goods," says Winarno. "As a product of the latest technology, biotech crops must also be applied within a stewardship context by assigning agricultural extension workers whom farmers could interact with and who could answer their questions about the technology."

Based on his many experiences with biotech crops, he concludes that biotechnology development is a necessity. However, he emphasizes the need for an ethical foundation for biotech research and its products. "For example, we need to determine the origin of the gene that is inserted either into the plant or animal. Genes from pigs, for example, should not be used in biotechnology research projects because it is forbidden by the Muslim faith," Winarno elaborates.

As a farmer representative of NOFA, he is grateful that Indonesia has established the Biosafety Commission to monitor genetically engineered products. "They will make sure that products developed from biotechnology have thoroughly followed ethical considerations."

Shaikh Mohd Saifuddeen bin Shaikh Mohd Salleh

- Senior Fellow, Centre for Science and Environment Studies, Institute of Islamic Understanding Malaysia

> **Biotechnology is a branch of knowledge that is important to mankind. It is therefore crucial that this field be developed.**

The Voice of Islam for Biotechnology

Shaikh Mohd Saifuddeen bin Shaikh Mohd Salleh and Mahaletchumy Arujanan

The voice of Islam regarding knowledge, science, and technology has been clear from the time the religion was revealed to Prophet Muhammad almost 1,500 years ago. The first revelation as stated in verses 1 to 5 of Surah al-'Alaq says: "Read! In the name of thy Lord and Cherisher, Who created. Created man, out of a (mere) clot of congealed blood. Proclaim! And thy Lord is Most Bountiful. He Who taught (the use of) the pen. Taught man that which he knew not."

This verse emphasizes the need to pursue and have mastery of knowledge. A number of significant messages can be gleaned from this first revelation:

- Islam created and promoted one of the most vibrant civilizations in the world and it is believed that the Islamic civilization had created a second agricultural revolution as a number of new technologies and innovations in agriculture were introduced, resulting in an important transformation in this sector.

- This verse contains a scientific message in the form of a biological information with regard to the development of the embryo. This information was verified to be accurate by anatomists in the early 20th century. This further signifies the voice of Islam with respect to the importance of the biological sciences.

- The word *iqra'* in this verse is a directive for mankind to read. Reading is the key that can unlock many doors of knowledge. When reading becomes a culture, it would empower mankind with a vast amount of knowledge that has the ability to revolutionize the world.

- The word *qalam* in this verse is translated as "the pen." This gives the signal that, aside from reading, writing is equally important. One of the effective ways to disseminate knowledge is through writing, as ideas and thoughts are documented for others to dissect.

- Finally, the verse 5 of Surah al-'Alaq which gives the clear message to Muslims that all knowledge are made possible by the Will of God. For Muslims, all forms of knowledge belong to God. It is God who wills for mankind to know something through observation, trial and error, and research. In other words, knowledge, including biotechnology, are "taught" by God to mankind.

In essence, the first revelation of the Quran shows that Islam puts great emphasis on the pursuit and mastery of knowledge. There are many forms of knowledge, and it is the responsibility of Muslims to have someone within their midst to have mastery in the various branches of knowledge, including biotechnology.

Declaration on Biotech

Biotechnology is a branch of knowledge that is important in the modern world. Its applications can be found in many sectors — agricultural, biomedical, pharmaceutical, food production, and environmental sectors, to name a few. Such wide-ranging applications highlight the need for Muslims to view biotechnology as a critical branch of knowledge and to strive to pursue and master this knowledge.

Realizing this importance, the Islamic Academy of Sciences (IAS) drew up the "IAS Rabat Declaration on Biotechnology and Genetic Engineering for Development in the Muslim World", which was issued way back in October 2001.

The Declaration, among other things, noted the following:

- The applications of biotechnology could have far-reaching effects and favorable impact on the developing countries, many of which suffer from large and rapidly increasing populations, chronic food shortages and malnutrition, poor health, and profound environmental problems.

- Biotechnology and genetic engineering are areas where rapid and meaningful advancement can be readily made by the Organization of Islamic Countries (OIC), especially in attaining food security and promoting the pharmaceutical industry.

- Activities being carried out by many governments, academic institutions, and non-government organizations in the fields of biotechnology and genetic engineering, especially in agriculture, are appreciated by IAS.

- Advancement in biotechnology and genetic engineering underlines the importance of investment in basic sciences, which are the backbone of sustainable science and technology advancement, especially as there is very little biotechnological research and development in the developing countries.

- The significance of the sequencing of the human genome is acknowledged as an event compared to man's landing on the moon and described as a milestone in the history of science that will enhance research in human biology focused on diseases such as cancer, Alzheimer's, diabetes, and cardiovascular disorders.

- IAS takes into consideration the Universal Declaration on the Genome and Human Rights, adopted by the General Conference of UNESCO in 1997, which is the first worldwide instrument in the fields of biology, medicine, and genetics.

The IAS also highlighted some problems faced by Muslim countries vis-à-vis biotechnology in the 2001 Rabat Declaration. These problems include lack of a long-term biotechnology policy in many OIC countries, the small number of students enrolling in biotechnology-related disciplines, the lack of adequate infrastructure for biotechnology research in most OIC countries in order to sustain this fast-growing sector, the absence of coordination between agencies involved in biotechnology research and application, and the lack of up-to-date curricula for biotechnology as well as shortage of qualified teaching staff. The IAS proposed that an Islamic biotechnological fund be established in order to help "poorer OIC countries to transfer biotechnology know-how from other countries, and develop and utilize it to achieve national food security."

> **"It is important to ensure that biotechnological development would bring forth benefits to mankind and the environment and not the opposite."**

Aside from the systemic problems identified by the IAS, it is also interesting to note that major breakthroughs in molecular biology and genetic engineering have raised many legal, ethical, and social questions. Such legal, ethical, and social dilemma are given serious attention by Islam and Muslim scholars. It is important to ensure that biotechnological development would bring forth benefits to mankind and the environment and not the opposite. On this matter, the IAS proposed that a multidisciplinary group made up of "scientists, technologists and Islamic scholars be set up to study the various facets of social and ethical issues."

It is also equally noteworthy that one point stressed in the Declaration was the recognition that genetic engineering has been defined as an unnatural insertion of a foreign sequence of genetic codes in the midst of the orderly sequence of genetic codes developed through millions of years, which is a profound intervention, with unpredictable consequences. Such sensibility would act as a reminder of the importance of not causing unwanted effects due to biotechnological developments.

It is not surprising then to see the IAS proposal for a moratorium on "the release of genetically engineered organisms and on the use of genetically engineered (GE) foods, until sufficient knowledge has been acquired to make it possible to judge how far it is safe for human health and the environment to exploit this technology. This is the "prevention is better than cure" approach suggested by the IAS.

Moving Forward

In essence, Islam stresses the need to preserve a harmonious three-dimensional relationship — i.e., relationship between mankind and God, relationship among mankind, and relationship between mankind and the environment. We can factor in biotechnology into this three-dimensional relationship to see how Islam views biotechnology.

Relationship between mankind and God: While "new" knowledge is welcomed by believers of Islam in line with the spirit of iqra', Islam also stresses the fact that all knowledge, including biotechnology, belongs to God, and only by God's Will is mankind able to obtain knowledge.

With regard to biotechnology, mankind has been given the tool to do many things that involve manipulation at the biomolecular level. From the perspective of Islam, what is important is for mankind not to have the inclination to "play God" or to "deny the existence of God." This is crucial in order to ensure that the relationship between mankind and God is protected. In other words, believing in what biotechnology can do for the betterment of mankind should strengthen one's belief in God.

Relationship among mankind: From Islam's point of view, biotechnology should not be the technology of the elite few. The benefits of biotechnology should not be accessible only to certain countries, certain companies, or certain individuals, as this would be tantamount to monopoly, which is not allowed in Islam. For Muslims, whatever is developed should be beneficial for the greater good of mankind.

Relationship between mankind and the environment: Biotechnological advancement has the potential to either improve or damage the environment. Believers of Islam are reminded of the need to ensure that the environment does not become a victim of mankind's greed.

Take Home Message

Biotechnology is a branch of knowledge that is important to mankind. It is therefore crucial that this field be developed. If its development falls within the ambit of the three-dimensional relationship mentioned above, Islam permits and supports it. What Islam stresses is the need to be cautious so as not to affect this all-important relationship.

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