

will be extremely important for bio-remediation and bio-monitoring.

(iii) Make new gains: Wild genetic resources of plants and livestock, including underutilized crops with the resilience and adaptability to the emerging climate change need to be conserved and used as a potential resource for crop/breed improvement. This has to come from the safe and responsible use of recombinant DNA technology leading to the creation of novel genetic combinations, which can confer tolerance to drought, flood, salinity, heat, pest and disease outbreaks.

The work in progress at MSSRF using genes for mangrove species is an example. Public good research institutions should serve as pre-breeding centres and work with farming communities in a participatory breeding mode so that genetic diversity and genetic efficiency can be combined. This is essential for sustainable agriculture.

The above Nine-Point Charter provides a road map for fostering stewardship in the conservation, sustainable use and equitable sharing of the benefits of agricultural biodiversity in an era of cli-

mate change. This is the pathway towards ushering in an era of biohappiness, characterized by the sustainable use of bioresources for strengthening and safeguarding harmony between humanity and environment.

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MEETING REPORT

GM technologies*

As of 20 August 2008, the world's estimated population was 6.689 billion. The challenges of the world's population growth, global warming, and constantly increasing prices of fuel and food are putting us into the biggest crisis. This crisis warrants the need to take a serious look at the technologies that can help us address these new challenges. Millions of people in different parts of the world are facing starvation due to food shortage and also increasing prices of food. Genetic modification (GM) technologies can offer a multitude of sustainable development solutions. However, the adoption rate of GM technologies by developing nations lags behind that of the developed world, most probably due to lack of awareness of their applications or because of a cautious approach in the adoption of GM technologies.

A conference was recently organized in Malaysia to look at the propositions offered by GM technologies, considerations in the adoption of GM technologies, the way for optimum utilization and

delivery of GM technology benefits, and the public and private perspective on the way forward. This conference was a satellite event to the Malaysia Agriculture, Horticulture and Agrotourism exhibition 2008 (MAHA 2008), the region's largest exhibition that showcases the latest technologies and innovations in the agriculture, agro-based, horticulture and agrotourism industry. The conference included thirteen invited speakers, four sessions and was attended by about 300 participants, including scientists from private and public institutions, representatives from key government agencies, private sector, industry, non-government organizations and other stakeholders of the biotech industry. Some views which provide a flavour of the conference are highlighted here.

The policies of the Malaysian government are pro-biotechnology; the Malaysian Biotechnology Corporation (Biotechcorp), the lead agency for biotechnology development in Malaysia, is working hard to ensure that the objectives and strategies under the National Biotechnology Policy are fully deployed and goals achieved. Malaysia aims to become a biotech hub and is targeting to have at least 5% contribution from the biotech sector to the national gross domestic product by 2020. This was echoed in opening remarks by Y. B. Dato Iskandar Mizal Mohmood (CEO, Biotechcorp). He also highlighted that research and development, funds for research and commercialization, and in-

centives are the key drivers in the biotech industry.

In the opening talk, an in-depth review on the sustainability challenges facing the world today and appropriate solutions was presented by C. J. Leaver (University of Oxford). He highlighted that by 2050 the world population will be more than 9 billion. Currently, more than 50% of the world's population lives in urban areas and the largest increases in population will occur in the cities of Asia and Africa. To meet the demand for food in 2050, it will be necessary to double the total production of food, triple the crop yield per hectare and do it on the same area of agriculture land with limited water. For this, GM technologies offer sustainable solutions.

According to Leaver, our main challenges are: to find what level of population is truly sustainable; to address the global food security in order to avoid predicted deficits as early as 2020 and to deliver an environmentally sustainable doubling of crop production by 2050 on essentially the same area of land; to meet the increased consumption of meat, cereals and edible oil by affluence; to reduce our dependence on and ultimately replace petrochemicals with renewable chemical feed stocks from plants and to combat climate change, global warming and drought and ameliorate its impact on crop productivity. He also highlighted that limited resources, low agricultural productivity, diminishing productive land/

*A report on 'GM Technologies: Addressing Global Sustainability Needs and Challenges', held at Palace of the Golden Horses, KL, Malaysia on 18–19 August 2008, and jointly organized by the Malaysian Biotechnology Corporation; Malaysian Agriculture Research and Development Institute; Universiti Putra Malaysia; Academy of Science, Malaysia; Malaysian Bio-industry Organisation, and Malaysian Biotechnology Information Centre.

water, poor distribution of food, misguided priorities, distribution/storage/transportation, growing population, low purchasing power, civil strife and war are the reasons why developing countries have problems with food. By drawing the attention of the audience to the Food and Agriculture Organization's (FAO) report which mentions '... in those countries where transgenic crops have been grown, there have been no verifiable reports of ... health or environmental harm', Leaver hinted that now and in the future making sure everyone has enough to eat is more about politics than science.

M. Diran (West African Biosciences Network, Dakar, Senegal) spoke on 'Agricultural biotechnology and the challenges of food security in Africa'. According to him poor infrastructure, management and husbandry problems, degradation of natural resource base, weak markets and socio-economic constraints, and biological and environmental constraints such as low soil fertility/lack of fertilizers, drought, pest and disease stress, and global climate change are the challenges in Sub-Saharan Africa. Diran highlighted the lack of funds, limited technical expertise, slow development of the biotechnology sector, inadequate IPR infrastructure, and the government not taking a more active political role in promoting the technology, as challenges of the biotech industry in Africa. South Africa grows GM maize, GM soybeans and cotton. According to Diran, the African population will double to 1.5 billion by 2025 and hence more efforts need to be made. We should exploit GM technologies and act now on the existing and upcoming challenges to avoid the crisis of food, feed and bio-fuel, according to Diran.

B. Chassy (University of Illinois, USA) gave a comprehensive overview on 'Risk benefit analysis of agricultural, industrial and healthcare biotechnology for developing nations'. He mentioned that those who oppose GM technologies may regard its use as 'playing God with nature' and 'opening Pandora's box'. However, GM technologies are simply a new, safer and more precise way to transfer genes. Chassy justified his statements by providing facts about genes, and examples of mutation breeding and the use of high-energy radiations to create new crop varieties. He also highlighted that while using GM technologies, we deal with genes that are already ubiquitous in the environment. For instance, in Mexico,

90% of stool samples have ampicillin resistance gene (*Amp*^R); 50% of the *Escherichia coli* of each French person is resistant to ampicillin, and each French person deposits 250 million to 2.5 billion *Amp*^R genes into the environment every day. Chassy then asked the audience how GM crops were dangerous to the environment? On the labelling of the products derived from GMOs, Chassy mentioned that it promotes fear about GMOs, and the risk perception of consumers is emotional. He suggested that scientists and educators need to improve risk communication with the public.

On 'Religious and bioethical considerations', I. A. W. T. Wan (Universiti Malaysia Terengganu, Malaysia) gave a comprehensive talk and highlighted that the changes brought about by GE technologies will continue to challenge the existing frontiers of both knowledge and human conscience, which have been moulded by centuries of deeply held beliefs of what is right and what is wrong. According to Wan, ethical and religious response to modern biotechnology (GM technologies) will no doubt be clouded by perceptions. However, the human ingenuity and the quest for advancement will eventually and inevitably recognize the benefits of GE technologies.

Addressing public concerns, perception and misconceptions about GM technologies, GMOs and their products is critical to convince people to adapt GM foods or GM products, and L. Alda (Council for Biotechnology Information, Brazil) shared Brazil's experience on this issue with the audience. She highlighted that science-based information is the key to educate people and to address their concerns about GM foods and products. She also highlighted the importance of communication tools such as websites, books, effective journalism, trustworthy spokespersons, newsletters, newspapers and organizing workshops, debates, speeches, etc. to inform, update and clarify concerns and misconceptions of people.

T. Paul (National Institute of Education, Singapore) spoke on the GM technology transfer to benefit producers and consumers. He highlighted that the world's population will be more than 10 billion in 2050, and that there is a need to significantly increase the supply of the 30 key crops essential for humankind. He also highlighted that we need crops which can grow under adverse environ-

mental conditions, so that those who chose to live there can have decent livelihoods. R. Paarlberg (Harvard University), giving a comprehensive talk on 'Explaining the resistance to agricultural biotechnology', highlighted that there is no resistance to genetic engineering in medicine and the need to use GM technologies. He also told audience that there are no new risks to human health or the environment from GMOs approved by regulators so far, and the existing resistance to GMOs in agriculture is due to the lack of understanding the science behind it.

An in-depth overview on 'Creating a conducive environment for the development of modern biotechnology using the Cartagena protocol to promote biotechnology' was presented by L. K. Drew (University of Oklahoma). He highlighted that we should pay attention to the experiences of other countries and learn from them. Giving examples of what is happening in the agriculture sector of India, China and other countries, Drew highlighted that India's regulatory system is the most complex, but India is rethinking on the regulatory system to make second green revolution using GM technologies. H. Desiree (University of the Philippines) delivered a talk on 'Overcoming challenges and risks in the adoption of GM technologies, experiences and lessons learned from the Philippines'. According to her, sustainable production of food, feed, fibre and fuel; poverty alleviation; improved health and nutrition; to achieve global competitiveness and to protect the environment are the main components of the overall national policy to achieve sustainable development. She highlighted that modern biotechnology is not a silver bullet but an option which needs to be used safely and judiciously to achieve the goals of sustainable development. Based on lessons learned in the Philippines, political buy-in, regulatory issues, access to technology, and market uncertainties are challenges in the adoption and commercialization of GMOs and products derived from GMOs, Desiree added.

China and India are the major players in Asia. H. Yang (Beijing Genomics Institute, China) presented an overview on 'Challenges and opportunities in biotechnology industry of the developing countries'. He projected the increase in global population, impacts of climate change and the increase in oil prices as

challenges. He noted that traditional plant breeding does not produce new varieties fast enough and we need better technologies, and these are GM technologies. He also highlighted that China has developed 'super hybrid rice' which can help the country to remain self-sufficient with regard to food grains.

K. A. B. Umi (Malaysian Agriculture Research and Development Institute; MARDI) spoke on 'Public research in the forefront of Malaysian biotech landscape' and highlighted that MARDI is using GM technologies to improve local varieties of rice, papaya, pineapple, chilli, pomelo, passion fruit, etc. and noted that for the contained trials for GM crop evaluation, researchers and research institutions need to comply with the National Biosafety Act 2007, once it is enforced. On the sidelines of the conference, K. Nagulendran (Principal Assistant Secretary of Malaysia's Ministry of Natural Resources and Environment) mentioned that the Biosafety Act 2007 gives a clear direction on the regulatory framework on GM. This Act is not intended to disrupt the R&D activities, but researchers should act in accordance with the Act, he added. The Malaysian Government supports modern biotechnology, but wants to make sure that the biosafety framework (Biosafety Act) is in place to protect human, plant and animal health, environment, and biological diversity.

Malaysia is the main player in the production and export of palm oil, and the Malaysian Palm Oil Board (MPOB) is dedicated to oil-palm research. G. K. Parveez (MPOB) gave an in-depth over-

view on the current status in oil-palm research and the challenges in the commercialization of transgenic oil palm. He highlighted that MPOB is using GM technologies to develop oil-palm lines which can give more oleic, stearic, palmitoleic and ricinoleic fatty acids, and explore ways to increase lycopene content, and the possibility of synthesizing biodegradable plastic in oil palm. Ongoing work at MPOB is only for R&D purpose and palm oil available in the market is not genetically modified, he clarified.

In the Asia-Pacific region Malaysia accounts for less than 0.5% of biotech revenues. Lack of innovations, lack of skilled personnel, and lack of entrepreneurial strategies, as well as limited source of financing for start-up companies were projected as the challenges for Malaysia in developing agriculture biotech industry by S. C. Cheah (ACGT, Malaysia), while talking on the research innovations and regulatory considerations in developing agriculture biotech industry in Malaysia. She believes that Malaysia's mega-biodiversity, established commodity crops (cocoa, oil palm, and rubber), multimedia super corridor (MSC) which provides and leverage for bioinformatics and the strong government support provides opportunities to develop agriculture biotech industry in Malaysia. Cheah also claimed that her company has completed the sequencing of oil-palm genome along with a USA-based collaborator. Utilization of GM technologies is the best option in creating oil crops to meet the demand of feed and biofuel in a sustainable manner, she added.

In different parts of the world, millions of people do not get enough food. But, it could be argued that hunger-alleviation arguments are misleading; transgenic crops are developed by mainly multinational companies (MNCs) based in the developed world. MNCs own the patent rights. Farmers in poor and developing countries depend on seeds supplied by these MNCs. In addition, there are some concerns over the impact of gene transfers through cross-pollination, resulting in hybridization with related crop plant species. On the other hand, according to a World Bank report, we are currently facing a major food crisis where food prices have increased due to an increased demand, which is expected to double by 2030. As a result, about 100 million people will starve if the current developments continue. Therefore, the food crisis will worsen. Each year the world's population increases by about 70 million people. Agriculture has become critical to the future of our planet and humanity. By understanding the benefits offered by GM corn, soybean, cotton and other crops, it appears that GM technologies can offer the best option to address the challenges in a sustainable manner for global sustainability. In fact, in the due course of time we have to embrace GM technologies.

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