

was also addressed. The conference was largely dominated by statistical genetics and examples of quantitative traits in animals (including humans), although some excellent presentations on plant systems were also made by Qifa Zhang (on heterosis), Ed Buckler (on association mapping) and Fred Hospital (on marker-assisted selection). It was also interesting to learn that methods of QG (including QTL analysis and association mapping) can be applied to the study of behavioural traits, genome imprinting (epigenetics), copy number variants (CNVs) and cis-SNPs and heterosis-environment interactions. The organizers plan to make the videos and presentations of the lectures available on the web.

The only criticism which the author has about the recent developments in the area of QG and the presentations made at ICQG3 is the widening gap between animal/plant breeders (including molecular breeders) and the geneticists on the one hand, and the statisticians on the other. There are only few practising animal or plant breeders, who understand statistics underlying the genetic analysis of QTs, and still fewer statistical geneticists, who ever practice animal and plant breeding. Therefore, there is a need to develop hu-

man resource with training in both genetics and statistics to address the complex problems of genetic dissection of complex QTs.

There appears to be a lack of activity in this area of research in India, where we have not been able to keep pace with the recent developments in the field of QG. There is hardly any school of statistical genetics with workstations having powerful supercomputers for QG research. The centres of bioinformatics established so far are more oriented towards genomics research rather than QG. Consequently, no statistical tools for research in the area of QG are being developed in India. Also, application of the latest statistical tools for genetic dissection of QTs (developed elsewhere) in animal/plant systems is being practised at few centres and that too rather superficially. The funding agencies in India (ICAR, ICMR, CSIR, DST, DBT, etc.) need to take notice of this poor state of the science of QG in our country and take remedial measures to improve the situation. We can certainly learn a lesson from research activity in our neighbour country, China, where not only high-quality research in QG is underway in different laboratories, but national and international conferences with participa-

tion from around the world are regularly organized to help Chinese scientists interact and collaborate with those from other parts of the world. A major effort in India is needed to develop centres of statistical genetics with emphasis on QG, both in animal and plant systems.

1. Pollak, E., Kempthorne, O., Bailey Jr, T. B. (eds), *Proceedings of the International Conference on Quantitative Genetics*, Iowa State University Press, Ames, Iowa, 1977.
2. Weir, B., *Genetics*, 1987, 117, 601-602.
3. Weir, B. S., Eisen, E. J., Goodman, M. M. and Namkoong, G. (eds), *Proceedings of the Second International Conference on Quantitative Genetics*, Sinauer Associates, Sunderland, 1987.

ACKNOWLEDGEMENTS. I thank Indian National Science Academy, New Delhi for nominating me to visit China under CAS-INSIA Bilateral Exchange Programme to participate in ICQG3.

P. K. Gupta, Molecular Biology Laboratory, Ch Charan Singh University, Meerut 250 004, India.
e-mail: pkgupta36@gmail.com

MEETING REPORT

Promising achievements and new challenges in agriculture biotechnology*

By understanding global trends and national and regional needs, most of the countries in Asia have been visible in articulating their support for agribiotechnology as a new engine for economic growth. To place Malaysia in an advantageous position in the rapidly growing

national, regional and global agribiotechnology market, there has to be a policy in place. The Malaysian Government had launched the National Biotechnology Policy in 2005, and advancement of agribiotechnology is a part of it. The 4th Asia Pacific Conference on Plant Tissue Culture and Agribiotechnology 2007 (APaCPA-2007) was held recently in Malaysia to look at the current agribiotechnology trends and scenario in Asia, to showcase what has been achieved so far and review the challenges and opportunities in agribiotechnology. The theme of the conference was 'Biotechnology for better food, health and quality living'. There were 12 plenary talks, seven concurrent sessions, and an embedded trade

exhibition, business forum, and a one-day 'orchid symposium'. About 430 registered participants and 103 speakers from different institutions belonging to 28 countries participated in this five-day event.

M. G. K. Jones (Murdoch University, Perth, Australia) in his opening plenary lecture spoke on the current status of agribiotechnology in the Asia region, and presented examples of success and discussed future prospects for development. He highlighted that the world population will increase by about 3 billion from the current value to about 9 billion by 2050, and a large proportion of this increase will be in the Asia-Pacific region. He projected providing enough food for the ex-

*A report on the 'Asia Pacific Conference on Plant Tissue Culture and Agribiotechnology 2007', held at PWTC, Kuala Lumpur, Malaysia during 17-21 June 2007, and organized and sponsored by AIMST University, Ministry of Agriculture and Agro-based Industry, and State Government of Kedah Darul Aman in collaboration with 11 institutions and under the auspices of 'Asia Pacific Association of Plant Tissue Culture and Agribiotechnology'.

panding population, improving human health and living standards, replacing fossil fuels with renewable energy, anticipating and/or responding to climate change, more efficient use of water and fertilizers, and preserving the environment for future generations as challenges for agribiotechnology in the Asia region. He emphasized that world trade poses threats and good opportunities for the transfer of plant and animal pathogens, which makes plant and animal biosecurity important than ever before. He affirmed that challenges could be balanced by rapid advances in the science and knowledge of diagnostics, production, and quality traits. He also discussed the major advances in scientific knowledge and technology related to agribiotechnology, including genomics, proteomics, metabolomics, and bioinformatics and systems biology. Marker-assisted breeding for crop and livestock improvement, new products to promote the health and well-being of consumers, and the development and use of various GM crops were projected as examples of promising achievements. Based on recent advances in metabolic engineering of oilseed crops and the use of plants in therapeutics production, he stated that these advances are only in the early stages of application and in due time full potential will be tapped which will benefit society, human health and the environment, and that will meet the food, feed and fibre needs of the growing population in Asia and rest of the world in a sustainable manner.

Y. Othman (University of Malaysia, Malaysia) in her plenary talk discussed various molecular techniques and strategies which could be used for improvement of tropical crops, especially to deal with virus infection and unique biotic and abiotic challenges in agribiotechnology. She also highlighted the need to bridge the knowledge gap for many tropical crops, comparative approaches, need to use marginalized land, disease-resistant genes and importance of collaborative efforts to tackle new challenges in agribiotechnology. N. Najimudin (Universiti Sains Malaysia, Malaysia) spoke on nitrogen fixation genes in Gram-positive bacteria, their evolution and diversity. S. Swarup (National University of Singapore (NUS), Singapore) discussed various applications of metabolomics and genomics in understanding plant metabolic pathways. M. Otani (Ishikawa Prefectural University, Japan) highlighted the poten-

tial of quality improvement of sweet potato by increasing amylose content in sweet potato starch by inhibition of *SBEII* gene expression.

The micropropagation technique, a proven means of producing identical plants on large scale, is an essential component of plant biotechnology. K. Schubert (BioSynectics LLC, USA) discussed the emerging opportunities and associated challenges in plant biotechnology and tissue culture. H. Randy (ISAAA, Philippines) gave an overview on GM technology and elaborated on how it complements traditional breeding. S. C. Fernando (CRI, Sri Lanka) presented the Sri Lankan experience in developing a reliable method for clonal propagation of coconut, which is an important palm in tropical countries. He highlighted various limiting factors and achievements in coconut clonal propagation. C. L. Keng (USM, Malaysia) discussed the production of artemisinin from cell suspension culture of *Artemisia annua* L.

A. Komamine (TU, Japan) highlighted production of salt stress tolerant rice. Z. Zhu (CAS, China) presented different issues related to development of transgenic rice in China. Oil palm is an important crop in Malaysia and other tropical countries, and to increase palm oil yield is a challenge. M. Hamidah (GBLSB, Malaysia) discussed in-depth, the efforts of Guthrie in the improvement of oil palm tissue culture process and highlighted the use of protein markers and hormonal profiling approaches in improvements of media formulations. H. E. Chio (NTU, Taiwan) updated the audience on green super bioinsecticide for food crops and fibres. S. R. Thengane (NCL, India) highlighted biodiversity in *Calophyllum* species and discussed key aspects in its micropropagation.

M. V. Montagu (IPBDC, Belgium) in his plenary talk gave an in-depth overview on systems biology and plant-based sustainable economies. He highlighted the recent technological advances and avowed that the organization of multidisciplinary networks, technology transfer, knowledge sharing, and more dynamic interactions between molecular geneticists, biochemists, plant breeders, ecologists and economists will be a key to future progress in delivering the benefits of technological advances. S. Natesh (DBT, New Delhi, India) highlighted the achievements and new challenges in Indian biotechnology. By discussing the success of

programmes which were supported by CSIR, DBT, NBDB and ICMR, he claimed that several interesting leads have been generated in terms of therapeutically important compounds, local plant-based pesticides, and plant-based natural dyes and other gene products of interest. He also highlighted issues such as lack of human resource with right capacity, absence of interdisciplinary crosstalk, limited number of universities and research institutions engaged in innovation and product development, limitations of IPR/regulatory system(s), lack of transdisciplinary institutional structure, inadequate strategic programming, weak or non-existent public-private partnerships, and insufficient programme-management skills in funding agencies as real barriers to the advancement of Indian biotechnology.

D. Cowan (RCAM, UWC, Cape Town) spoke on current status and future developments in the field of metagenomics and its applicability in agribiotechnology. R. Samudrala (UW, USA) presented novel computational methods for prediction of relationships between proteins basically based on comparative genomics. He highlighted that these predictions are similar to experimentally derived interactions. These techniques can be exploited to aid in rational engineering, either by genetic modification or by marker-assisted breeding and can help in improving human health and quality of life.

P. Lynch (UD, UK) discussed advancements in plant cryopreservation and highlighted the importance of *in vitro*, long-term conservation of *Allium* germplasm and initiatives of the IPK genebank. K. Harding (DAMAR, Scotland, UK) gave an overview on plant and algal cryopreservation, its importance and various approaches to confirm the genetic integrity of stored samples. He highlighted the concept of 'cryobionomics'. N. K. Nirala (Jawaharlal Nehru University, India) highlighted promising achievements made in the development of artificial seeds of grapes and its importance in the grape industry. M. D. D. Bandupriya (CRI, Sri Lanka) spoke on current status of cryopreservation of encapsulated plumules of coconut. Neem (*Azadirachta indica* A. Juss.) is an economically important plant and G. S. Shekhawat (DBB, India) discussed efforts to propagate this plant rapidly using tissue-culture techniques. R. E. Litz (UF, USA) highlighted the importance of *in vitro* manipulation of tropical fruit species. A. A. Kulkarni

(University of Pune, India) discussed production of low-volume high-cost anti-cancer compound, 'taxol' from *Taxus* species and highlighted the potential of *Withania somnifera* in healthcare. Country status reports on what is happening in China, India, Korea and Malaysia were discussed by X. Z. Hong (PU, CAS, China), S. Natesh (DBT/MST, India), J. R. Liu (KRIBB, Korea), and A. Latifah (UKM, Malaysia) respectively. P. P. S. Teng (NIE-NTU, Singapore) gave an in-depth overview on the Asian stand in accepting GM crops. He highlighted the influence of ongoing international discussions over biosafety, food safety, labelling, trade (WTO, TRIPS) and biosafety regulatory frameworks (UNEP-GEF) on Asian countries. S. S. Rabian (FELDA, Malaysia), P. G. Bagali (Infovalley, Malaysia), A. Anwar (Synamatix, Malaysia), B. A. Saeed (University of Karachi, Pakistan), M. R. Naghavi (UT, Iran), and A. Eimanifar (IARC, Iran) highlighted various aspects of molecular markers, bioinformatics and their applications in modern agribiotechnology.

K. M. Yusuf (UPM, Malaysia) in her plenary talk presented potential impact of Newcastle disease virus (NDV) on human cancers and highlighted the achievement(s) in defining anti-NDV peptides which can inhibit replication of the virus. Representative of G. H. Cassell (Eli Lilly, Indianapolis, USA) discussed the role of the R&D-based pharmaceutical industry in addressing global health challenges and elaborated on Lilly's multidrug-resistant tuberculosis global partnership as a model. Y. Chisti (MU, New Zealand) gave an extensive overview on the production of high-value products from microalgae using biochemical engineering. He highlighted that industrial production of high-value products from microalgae can be expensive and the expense is accentuated by inadequacies in photobioreactor engineering. H. U. Eng (GS, Sabah, Malaysia) discussed the current scenario in aquaculture industry in Asia (US\$ 100 billion globally) and emphasized that agribiotechnology can help aquaculture industry by developing natural plant anti-viral proteins, phyto-oestrogens for sex manipulation, seaweed hydrolysates for secretagogue and immunostimulant properties,

algal DNA vaccines and for biomass transformation to reduce the usage of fishmeal in aquaculture feeds.

M. W. Beilharz (UWA, Australia), A. C. Herington (QUT, Australia), N. Asokanathan (AIMST University, Malaysia), T. V. Riley (QE-II-MC, Australia), L. M. Smith (CRC, Australia), S. L. Tan (Amgen, USA), C. Kahler (UWA, Australia), S. Low (Stem Life, Malaysia), V. Tanavde (Bioinformatics Institute, Singapore), and S. A. Dhanaraj (AIMST University, Malaysia) discussed various aspects of healthcare biotechnology to highlight achievements and challenges in the field. V. S. Bisaria (IIT-New Delhi, India) highlighted impact of symbiotic fungi on the production of important metabolites by plant cell culture. M. R. Samian (USM, Malaysia) discussed progress made in conversion of palm oil to bioplastic, which could be used as an alternative to non-degradable plastic. F. Chen (UHK, Hong Kong), G. A. Ravi Shankar (CFTRI, India), S. Vikineswary (UM, Malaysia), K. Madhusudhanan (CPCRI, India), and K. Marimuthu (AIMST University, Malaysia) highlighted prospects of functional food and nutraceuticals, value-added products from GM crops, mushrooms with antioxidant activities, use of arecanut waste as substrates for low-cost production of oyster mushroom, and limitations in snakehead (freshwater fish, *Channa striatus*) propagation respectively.

J. Arditti (UCI, USA) discussed the history and biotechnology in orchid propagation in the opening plenary talk of the one-day orchid symposium. He highlighted that orchids were in the forefront of plant biotechnology since the last 100 years. C. Y. Neng (EcoFirst Lab, Malaysia) updated audience on orchid smuggling using the example of slipper orchids (*Paphiopedilum* species), and highlighted the use of DNA fingerprinting technology and other measures to tackle it. Z. A. Aziz (UMS, Malaysia) discussed effectiveness of *in vitro* technology and cryopreservation to conserve orchid species endemic to Sabah (Malaysia). J. A. Harikrishna (UM, Malaysia) highlighted the biotechnological approaches to protect economically important orchids from Cymbidium mosaic virus and Odontoglossum ringspot virus. P. Kumar (NUS)

presented promising achievements made in understanding regulatory mechanisms underlying orchid flower development.

In the session on biosafety and bioethics, B. Chassy (UI, USA) gave an overview of new developments in understanding safety of GM crops and emphasized that the scientific community needs to educate society on GM crops. S. Shantharam (Biologistics International LLC, USA) highlighted the drivers for appropriate regulatory oversight of agribiotechnology, and the importance of public confidence in technology or biotech-based products. B. Nathwong (BIOTEC, Thailand) presented an overview and the achievements of different programmes implemented in Thailand to improve public awareness on GM crops, biosafety and bioethics. All other speakers as well as the poster presenters also highlighted various achievements along with challenges in different sectors of agribiotechnology. The business forum at the end of the conference highlighted the challenges and opportunities in agribiotechnology in the Asian region, to create wealth for the well-being of the peoples of the region and the world at large.

Considering the influence and growing importance of biotechnology in all parts of the world and Asia's ardent desire to become self-sufficient in food, health and quality living, this conference provided a platform to understand the current scenario, multidimensional challenges and opportunities in agribiotechnology. Encouraging feedback was received from the participants. The mission to meet new challenges in agribiotechnology is hard but not impossible. Information gathered through this conference could be useful to develop a priority-based agenda for the further development of agribiotechnology in Asia. Nonetheless, addressing new issues effectively and in time will be a key to make sure that as Asians we will not be left behind in agribiotechnology.

Bhore Subhash Janardhan, Molecular Biology Division, Melaka Institute of Biotechnology, Lot 7, Melaka International Trade Center City, Ayer Keroh, 75450, Melaka, Malaysia.
e-mail: subhash@mib.gov.my