Expert Consultation on Agricultural Biotechnology for Promoting Food Security in Developing Countries

Mines Beach Resort, Kuala Lumpur, Malaysia

20-22 August 2008

PROCEEDINGS

Asia-Pacific Association of Agricultural Research Institutions (APAARI)
Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB)
Malaysian Agricultural Research and Development Institute (MARDI)

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Asia-Pacific Association of Agricultural Research Institutions (APAARI)
Maliwan Mansion, 39 Phra Atit Road, Bangkok 10200, Thailand

Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB)
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FOREWORD

The Asia-Pacific Association of Agricultural Research Institutions (APAARI) is an apolitical forum of the National Agricultural Research Systems (NARS). It has the mandate to strengthen the research capabilities of NARS, exchange information and assist in prioritizing NARS and regional needs in agricultural R&D. The Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB), one of the programs of APAARI, has been promoting application of agricultural biotechnology in the region. Some initiatives taken by them include organization of Expert Consultation on Status of Biotechnology in Asia-Pacific Regions (2002); High Level Policy Dialogue on Biotechnology for Food Security and Poverty Alleviations: Opportunities and Challenges (2005); and Brainstorming Sessions on Public-Private Partnership in Agricultural Biotechnology (2005 and 2008).

The Malaysian Agricultural Research & Development Institute (MARDI) has the national mandate to create, innovate, transfer and apply knowledge, competencies and services to transform the national food, agriculture and bio-based industries towards increased commercialization and competitiveness. MARDI's mandate in agricultural biotechnology R&D includes the effective application of biotechnology for crop and livestock improvement, industry alliances and the development of agricultural biotech products which can contribute to building food security in Malaysia.

The present Expert Consultation on "Agricultural Biotechnology for Promoting Food Security in Developing Countries" held on 20-22 August 2008 in Malaysia follows the recent worldwide concern over decline in agricultural production and the consequent sharp rise in food prices. The main objective was to review the status of research and application of agricultural biotechnology in the developing countries; develop a holistic approach to address food security issues, including the use of biotechnology; and identify strategies to overcome constraints to safe adoption of agricultural biotechnology for the benefit of small farmers in the developing countries.

The Expert Consultation had four technical sessions (Status of Agricultural Biotechnology Research and Application; Biotechnology Applications; Global and Regional Partnerships in Agricultural Biotechnology; and Issues in Adoption and Commercialization of Agricultural Biotechnology- Panel Discussion) followed by Break Out Group Discussion and Plenary Session.

There was general consensus that biotechnology has the potential to contribute significantly towards enhancing productivity, profitability and environmental sustainability. Yet to accomplish these, there is an urgent need for a holistic approach towards technological innovations and their adoption through closer farmer-scientist linkages. Specific recommendations were made on: (i) Strengthening biotechnology for agricultural diversification; (ii) Facilitating regulatory management; (iii) Strengthening South-South, North-South and public-private cooperation; (iv) Creating awareness by improving communication and education; and (v) Capacity building.

We do hope that wide circulation of these proceedings will generate awareness and appropriate action by the NARS to implement the strategic recommendations of this Expert Consultations. We thank all the participants representing academia, civil society and farmers' organizations, private sector and other stakeholder groups. Also, we express our appreciation of GFAR for providing partial funding support.

(Abd Shukor Bin Abd Rahman)
Director General, MARDI

(Raj Paroda)
Executive Secretary, APAARI

ACRONYMS AND ABBREVIATIONS

AARINENA	Association of Agricultural Research Institutions in the Near East and North Africa
ABSP	Agricultural Biotechnology Support Project
ACP	African Caribbean Pacific Group of States
AGERI	Agricultural Genetic Engineering Research Institute
AP	Asia-Pacific
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APCoAB	Asia-Pacific Consortium on Agricultural Biotechnology
APEC	Asia-Pacific Economic Cooperation
BARI	Bangladesh Agricultural Research Institute
CACAARI	Central Asia and the Caucasus Association of Agricultural Research Institutions
CGIAR	Consultative Group on International Agricultural Research
CPB	Cartagena Protocol on Biosafety
CSO	Civil Society Organization
DBT	Department of Biotechnology, Government of India
DG	Director General
ELISA	Enzyme-linked Immunosorbent Assay
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FARA	Forum on Agricultural Research in Africa
FSBR	Fruit and Shoot Borer-resistant
GFAR	Global Forum on Agricultural Research
GM	Genetically Modified
GMOs	Genetically Modified Organisms
GR	Golden Rice
Ha	Hectares
Mt	Metric tonne
HRD	Human Resource Development
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
INCANA	Inter-regional Network on Cotton in Asia and North Africa
IP	Intellectual Property
IPR	Intellectual Property Right
IRRI	International Rice Research Institute
ISAAA	International Service for the Acquisition and Application of Agricultural Biotechnologies
Mahyco	Maharashtra Hybrid Seed Company

MARDI	Malaysian Agricultural Research and Development Institute
MAS	Marker Assisted Selection
NARS	National Agricultural Research Systems
NBF	National Biosafety Framework
FARA	Forum for Agricultural Research in Africa
NIAS	National Institute of Agrobiological Sciences
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PCP	Product Commercialization Package
PCR	Polymerase Chain Reaction
PDR	Pathogen-derived Resistance
PHS	Pre-harvest Sprouting
PPP	Public-Private Partnership
PTGS	Post-transcriptional Gene Silencing
QTL	Quantitative Trait Loci
R&D	Research and Development
RABNet	Regional Agricultural Biotechnology Network
RNA	Ribonucleic Acid
SNP	Single Nucleotide Polymorphism
US	United States
WANA	West Asia and North Africa
WTO	World Trade Organization

Background and Objectives

Developing countries of Asia and the Pacific have made substantial progress at enhancing food security, reducing poverty and improving human development. This has been achieved largely through growth in agriculture leading to increased food and feed production and improved farm incomes. However, lately there has been stagnation in agricultural growth giving rise to concerns about food and livelihood security of large sections of population who make their living from agriculture and related enterprises. It is being felt that under the prevailing conditions, none of the developing countries in Asia and the Pacific will be able to meet all of the Millennium Development Goals by 2015. In terms of economic impact, it is estimated that the annual food import basket for least developed countries will nearly double that of 2000.

Developments over the last two decades indicate that biotechnology could contribute significantly towards enhancing productivity, profitability and environmental sustainability of farming systems. In 2007, eleven years since the first genetically modified (GM) crops were sown in the farmers' fields, the global area under GM crops had risen to 114.3 million hectares with 12 million farmers in 23 countries growing them. Besides GM technology, micropropagation, marker-aided-selection and genomics have established their own place in the repertoire of biotechnological tools for crop improvement. Molecular breeding approaches have started yielding practical results in the form of improved varieties with qualities of high yield and resistance to abiotic stresses.

Adoption of biotechnology tools and products has, however, been uneven with farmer-level adoption of GM crops limited still to a few crops and a few countries. Some of the factors that have restricted the adoption of biotechnology particularly by developing countries are lack of resources, limited collaboration between public and private sectors, lack of science-based public awareness, and concerns about environmental and health safety. The high cost of regulatory compliance and lack of technical competence in regulatory management have been quoted as the major reasons why public sector in developing world has been slow in releasing GM crops. These have not only added to the cost of GM seed that a farmer has to pay but also delayed the availability of improved products to farmers and consumers.

The main objective of this Expert Consultation was to bring together a wide spectrum of experts from Asia, Africa, the Pacific region, as well as from developed countries to deliberate on the scientific, policy, environmental and social issues related to application of biotechnology in agriculture. Through this deliberation we hope to assist developing countries in evolving effective strategies for safe and environmental friendly application of biotechnology to ensure food security. We also hope to create more awareness and share experiences so that countries adopt appropriate options suited to their needs and foster partnerships as a way of accelerating the pace of biotechnology adoption and reducing costs.

Opening Session

The opening address was chaired by HE Dato' Mustapa Mohamed, Minister of Agriculture and Agro-based Industry, Malaysia. Datuk Dr. Abd Shukor Abd Rahman, DG, MARDI and Dr. Raghunath Ghodake, Chairman, APAARI made welcome statements as sponsors and cosponsors of the Expert Consultation.

While welcoming the participants, Datuk Dr. Abd Shukor expressed appreciation of APAARI in organizing the Expert Consultation in Malaysia which, in his opinion, was a timely initiative emphasizing biotechnology as a key driver for agriculture sector. MARDI accords high priority to agricultural biotechnology and has initiated several programs utilizing genetic modification technology, genomics, marker assisted selection and biosensors for crop and animal improvement, and environment safety and amelioration. Datuk Dr. Shukor mentioned that international networking and collaborations have been highly beneficial in achieving the desired goals in Malaysia. Along with, new IP policy has created conducive environment for technology application and transfer.

On behalf of APAARI, Dr. Ghodake welcomed the participants mentioning that the presence of experts from different regions representing both developing and developed countries and specialized in diverse aspects of agriculture and biotechnology made the Expert Consultation truly international and intersectoral. He recalled the efforts of APAARI on policy promotion and R&D in agriculture biotechnology. More recent initiatives include expert meetings and policy dialogues on biofuels, climate change and regulatory management of biotechnology in the AP region. Dr. Ghodake emphasized that the current challenges of rising food prices provide opportunities for developing countries to adopt common and harmonized strategies to raise agriculture productivity and reduce poverty. APAARI would support NARS in developing policies and action plans to meet these challenges.

HE Dato' Mustapa Mohamed welcomed the participants and congratulated MARDI and APAARI for organizing this important event. He opined that the recent food shortages have come as a wake up call to make vigorous policy and R&D efforts towards increasing agricultural productivity. HE Dato' Mustapa Mohamed elaborated upon the efforts of Malaysian government in developing comprehensive food security policy aimed at increasing crop and animal production and improving supply chain to benefit the farmers and consumers. He stressed that biotechnology has to play an important role in achieving these objectives and expressed confidence that the Expert Consultation would present an effective action plan to translate biotechnology research into products that benefit farmers in developing countries.

Session IA: Status of Agricultural Biotechnology Research and Application–Global Developments

This session was chaired by Dr. Raj Paroda, Executive Secretary, APAARI and co-chaired by Mr. Ariffin Tawang, Deputy Director General, MARDI.

Prof. Bruce Chassy, University of Illinois in his presentation "Recent Research Advances in Agricultural Biotechnology" focused on new developments in designing crops for future agriculture. He stressed that remarkable productivity and profitability gains have been made during the last decade due to the adoption of transgenic crops modified for tolerance or/and resistance to herbicides and insecticides. Along with, there has been striking reduction in the use of agrochemicals and emission of greenhouse gasses. He highlighted recent research advances made towards increasing plant tolerance to environmental stresses such as drought, and improving nutritional quality. The use of siRNA mechanisms and transcriptional factors to modulate gene expression were also elaborated by Prof. Chassy. Potential applications of gene modulation technology and suggestions on safety management of novel transgenics based on this technology were presented.

Dr. Randy Hautea, ISAAA Global Coordinator presented the paper entitled "Global Status of GM/ Biotech Crops: Adoption, Impact and Future Prospects". Dr. Hautea provided detailed statistics on the increasing global area under biotech crops during the past decade accompanied by economic benefits accrued due to their cultivation. Farmers increased their incomes due to higher effective yields and decreased agrochemical inputs. In 2007, 23 countries grew biotech crops on an area of 114 million hectares and an additional 29 countries had been granted regulatory approvals for biotech crops to be used as food, feed or fiber. Dr. Hautea opined that there would be further diversification of biotech crops and the 'second generation' crop biotech products would exhibit enhanced output and quality traits such as improved nutritional levels, better fiber quality, longer shelf-life and higher levels of tolerance to abiotic stresses. He concluded that as a result of favorable political opinion, crop biotechnology applications would continually grow and complement conventional breeding to develop lower-cost food, feed, fiber, fuel and other products.

Prof. Chris Leaver, University of Oxford made a presentation on "Adoption of GM Crops for Food Security". He emphasized that the world would be facing a major challenge in feeding an estimated population of 9 billion by 2050 which would have to be met by doubling food production on a constant land area and with less available water. Along with, there is a need to ensure conservation of biodiversity and ecological resources and minimize the effects of climate change. He stressed to evaluate all available technologies including biotechnology and in combination with conventional approaches, deploy those that are most effective. GM technology, markers assisted selection, bioinformatics and metabolic engineering offer powerful tools for increasing crop productivity, improving biotic and abiotic stress tolerance and nutritional quality. For achieving food security and alleviating poverty in the developing world, these technologies must be applied not only in major crops but also in crops of local importance which are in urgent need of productivity and quality improvement.

Session IB: Status of Agricultural Biotechnology Research and Application–Country Reports

This session was chaired by Datuk Dr. Abd Shukor Abd Rahman and co-chaired by Dr. Raghunath Ghodake.

Dr. Umi Kalsom Abu Bakar, Director, Biotechnology Research Center, MARDI presented the "Status and Development of Biotechnology in Malaysia". The presentation focused on the application of biotechnology for improvement and production of quality varieties resistant to pests and diseases in crops of high local importance such as papaya, rice, pineapple, citrus, mangosteen, passion fruit, chili and orchids. Adoption of biotechnology has created new opportunities for Malaysia to increase food production and, hence, enhance its food security. Biotechnology is also being applied in bioprocessing research for the development of value-added food and non-food products as well as in biosensor research to produce kits and devices for reliable and rapid detection of chemical residues, plant and animal diseases as well as GMOs for agriculture and food industries. Tissue culture, molecular markers and reproductive biotechnology are the other tools applied for crop and animal improvement. Recently, researches on functional genomics, metabolomics and bioinformatics have been initiated to generate fundamental knowledge required for precision breeding. Emphasis has been placed on strong public-private sector partnerships, effective regulatory framework and public acceptance of biotechnology products as key ingredients for the successful growth of the biotechnology industry in Malaysia.

Dr. Le Huy Hum, Institute of Agricultural Genetics, Vietnam made a presentation on the "Status and Development of Biotechnology in Vietnam". Dr. Hum elaborated on the use of micropropagation techniques to produce healthy seedlings for the reforestation program in Vietnam. The technology is being improved by using bioreactor systems, artificial seeds and hydroponics. Inbred lines developed through androgenesis (rice and maize) and gynogenesis (maize) have been deployed successfully for hybrid breeding. Breeding for seedless citrus with the application of conventional and modern tools is currently being carried out. Molecular techniques of QTL and MAS are being applied for breeding rice and other crop plants with the objective of incorporating resistance to drought and diseases. Dr. Hum also stressed the importance of GM technology for crop improvement and for the production of plant based vaccines and antibodies. He informed that the general guidelines for commercialization of biotech crops have already been adopted in Vietnam and by 2020 selected GM crops are expected to occupy about 30-50% of total crop-area in the country.

Dr. P. Ananda Kumar, Project Director, National Research Center on Plant Biotechnology, India presented "Status and Development of Biotechnology in India". He emphasized that food security will become the most important social issue in India by 2050 as the population is expected to reach 1.5 billion and food production would have to be doubled to meet the projected needs. The only way by which the challenges of malnutrition, enhanced productivity needs and crop diversification can be addressed is through better resource management and breeding more productive, more nutritious and less resource input demanding crops. Dr. Ananda Kumar highlighted the role of various science and technology departments in India involved in promoting R&D in agricultural biotechnology. He also highlighted several achievements made with the use of tissue culture, marker-aided-selection and genetic modification technologies. He informed that India is now the world's second largest producer of Bt cotton and several transgenic crops are currently undergoing field trials. Emphasis is being placed on frontier areas of research such as structural and functional genomics with special reference to abiotic stresses, gene and promoter prospecting, bioinformatics and nanobiotechnology. He concluded by apprising the participants about the 'single window system' being developed in India for biosafety clearance of GM products.

Dr. Patcharin Tanya of Kasetsart University, Thailand presented the report entitled "Status and Development of Biotechnology in Thailand". She elaborated on Thailand's policies and strategies to utilize transgenic technology for production of value-added transgenics in crops that are important to Thai economy. The group of plants that are being targeted for improvement through biotechnological approaches comprise ornamental (orchids), energy plants (oil palm, cassava and sugarcane), industrial plants (eucalyptus) and environmental friendly rice. Emphasis has been placed on promotion of capacity building in research, biosafety management and social awareness and participation. The ultimate aim of these strategies is to improve knowledge and application of biotechnology to meet social needs, promote social awareness, and build capacity to take science based informed decisions.

Dr. Ibrahim Y. Hamdan, Executive Secretary, Association of Agricultural Research Institutions in the Near East and North Africa (AARINENA) presented the report on "Status and Development of Agricultural Biotechnology and Biosafety in West Asia and North Africa (WANA)". Dr. Hamdan explained the mission of AARINENA: (a) to contribute to the enhancement of agricultural and rural development in the WANA region through fostering agricultural research and technology development; (b) to promote exchange of specific and technical experience and information; and (c) to strengthen collaboration within and outside the region to achieve greater degree of self-reliance in food and agriculture. Of the various biotechnological tools being applied for crop improvement in the WANA region, tissue culture and micropropagation are commonly applied in most countries. Genetic engineering is increasingly finding wider application, while use of molecular marker techniques still in infancy. Upstream technologies like genomics and proteomics

are restricted to just a few institutes in the region. With the commercialization of GMOs in the WANA region in the very near future, their impact on environment needs to be studied to ensure protection of biodiversity. Dr. Hamdan also presented the current status of National Biosafety Framework (NBF) in the region informing that 11 countries had completed their NBFs.

Prof. Walter Alhassan from Forum for Agricultural Research in Africa (FARA) made a presentation on "Status and Development of Agricultural Biotechnology in Africa". Prof. Alhassan stressed that it would be necessary to raise cereal production in Africa from the current 1 mt/ha to at least 3.2-3.8 mt/ha to meet the food production needs. While modern biotechnology is one of the proven options, there are perceived risks to the environment and human health. Although scientists in US and EU have attested to the safety of agricultural GM products to human and animal health and environment, Africa is caught in the middle of GM debate. However, there is ample evidence of policy commitment to biotechnology in the continent. These commitments need to be translated into development of national policy framework followed by appropriate legislations in countries, wherever required. Capacity building in biotechnology and biosafety should be enhanced through training, provision of laboratory infrastructure and creation of centers of excellence. Currently, South Africa is the only country in the continent to have permitted commercial cultivation of GM crops while Burkina Faso and Egypt have given notice for commercialization of GM crops during 2008.

Session II: Biotechnology Applications

This session was chaired by Dr. Randy Hautea, Center Director and ISAAA Global Coordinator and co-chaired by Dr. Umi Kalsom Abu Bakar, Director, Biotechnology Research Center, MARDI. Five papers were presented in the session.

Dr. Gerard Barry, Coordinator, Global Rice Network, IRRI spoke on "Biofortification to Enhance the Quality of Food Crops". He pointed out that about half of the world population suffers from one or more micronutrient deficiencies due to the lack of access to a diverse diet. These deficiencies lead to a number of serious health and human development problems. The current approaches to address human micronutrient deficiency comprise advocacy for diverse diets and dietary education, provision of micronutrient supplements and fortification of basic food and food ingredients with one or more micronutrients. While supplementation programs may provide temporary relief in persistently critical situations, Dr. Barry suggested that fortification programs could reach large numbers of people, and being a food-based approach could be delivered through processed foods such as flour, cooking oils and bread. Dr. Barry informed that a worldwide program is underway to breed crops for better nutrition through biofortification of sweet-potato, maize, wheat, rice, common beans, and cassava. IRRI through the efforts of Harvest Plus Rice Crop Team and in partnership with international and national agencies is breeding rice varieties with increased iron, zinc, and β-carotene content. Dr. Barry also informed that by manipulating the expression of the soybean ferritin gene in the endosperm, it has been possible to increase the iron content in rice grain by a factor of four. Backcrossing of the Golden Rice trait into locally important varieties is underway in a number of countries and human bioavailability trials are planned.

Dr. Francis Ogbonnaya, Wheat Biotechnologist, International Center for Agricultural Research in the Dry Areas (ICARDA) presented his lecture on "Marker-assisted Selection in Plant Breeding". Dr. Ogbonnaya mentioned that while the traditional plant breeding is time consuming, advances in the field of molecular biology have offered tools which if appropriately deployed will improve breeding efficiency and effectiveness. He presented several examples of marker assisted selection (MAS) applications including

the transfer of *Cre1* gene for cereal cyst nematode resistance from hexaploid to tetraploid durum wheat and the pre-harvest sprouting (PHS) resistance in wheat varieties. However, despite its potential benefits, MAS is yet to become a routine tool in most breeding programs due to a wide gap between research and implementation, between private and public institutions and between developed and developing nations. Dr. Ogbonnaya stressed that for a successful transition from research on MAS to its application for development of new crop varieties, sufficient investments for upgradation of infrastructure and capacity building is needed. In addition, modification of some components of the breeding programs to bring about desired efficiencies and outputs would also be required.

Dr. Yung-Fu Yen, Senior Professor, National Chiayi University, Chinese Taipei presented his paper on "Biotechnology for Production of High Quality Disease Free Planting Materials". He focused on the role of plant biotechnology in maintaining healthy plants and to enhance their ability to withstand pathogen infections. Several strategies to produce disease free planting material were outlined, including the use of plant tissue and meristem culture along with diagnostic tools like biological indexing, electron microscopy, enzyme-linked immunosorbent assay (ELISA), polymerase chain reaction (PCR), and microarray detection. Of these, PCR based methods provide the greatest sensitivity. However, disease free planting materials may not provide protection against subsequent infections caused by vector transmitted bacterial and viral diseases. Dr. Yen elaborated on genetic engineering advances using virus-derived genes to confer resistance in plants, also known as pathogen-derived resistance (PDR). Expression of different virus sequences, e.g., coat protein, movement and replicase genes or truncated versions of them, as well as non-translated sequences, have proved to be highly effective in preventing or reducing viral infections. Mechanisms of RNA silencing or post-transcriptional gene silencing (PTGS) were described.

Dr. Takuji Sasaki from National Institute of Agrobiological Sciences (NIAS), Japan presented his paper on "Biotechnology in Germplasm Conservation". He emphasized the importance of germplasm conservation reminding that specific genotype cannot be recreated even with the most advanced technology. However, a wide array of information derived from plant genomics can be efficiently utilized to enhance the value of germplasm. Substantial genome sequence information is available in major cereal crops such as rice, maize, and sorghum as well as some fruits such as grape and papaya. Sequence variation among members of the same genus reflects the variation in phenotypes corresponding to cultivars, whereas the sequence variation among related genera gives information on gene pool diversity. As of 2008, a total of 243,000 plant accessions are registered and maintained at NIAS including 30,000 accessions of rice collected from all over the world and 2,000 accessions of Japanese rice landraces. The completion of the japonica rice Nipponbare genome sequence in 2004 which enabled a large-scale survey for single nucleotide polymorphisms (SNPs) has dramatically refined utilization of the rice germplasm. Genome wide SNPs are now being used for genetic mapping and detection of QTLs for important traits. As the genome sequences of other crops are elucidated, the significance of germplasm conservation based on genomics information will become indispensable for improving the quality and productivity.

Dr. Darshan Brar, Head, Plant Breeding, IRRI made a presentation on "Genetic Enhancement through Biotechnology in Rice". He explained how the application of Mendelian genetics and conventional plant breeding methods had helped in doubling rice production. However, by 2020, 25% more rice production would be required while overcoming the challenges posed by several biotic and abiotic stresses and less availability of land, water, agrochemicals and labor. To achieve this production level, high yielding varieties possessing multiple resistances to biotic and abiotic stresses with improved grain and nutritional quality are needed. Dr. Brar opined that advances in molecular biology and genomics offer new opportunities to meet these challenges. MAS based bacterial blight resistant rice varieties have been released in India, the

Philippines, Indonesia and China, while a number of varieties with *Sub1* gene conferring submergence tolerance are under evaluation. Dr. Brar also stressed that identification and pyramiding of major genes/ QTL for resistance to blast, gall midge, brown plant hopper, stem borers, drought, submergence, cold and salinity should be given priority in breeding programs. Transgenic rice lines have been produced for resistance to herbicides, diseases and insects, tolerance to abiotic stresses and improved nutritional quality. These have shown increased tolerance to bacterial blight and stem borers in contained field tests in India, China and the Philippines. Beta carotene locus in transgenic rice has been transferred into high yielding indica varieties by using marker assisted backcrossing. Future efforts were suggested towards enhancing micronutrients content and tolerance/resistance to drought, stem borer and sheath blight. Finally, Dr. Brar reminded that the new biotechnological tools though powerful are supplements to the conventional breeding and appropriate integration of the two is required to achieve the desired goals.

Session III: Global and Regional Partnerships in Agricultural Biotechnology

Four papers were presented during this session chaired by Prof. Bruce Chassy, Executive Associate Director, Biotechnology Center, University of Illinois and Dr. Hassan Mat Daud, Director General, Agro-Biotechnology Institute, Malaysia.

Dr. Gerard Barry in his presentation on "Golden Rice" focused on micronutrient malnutrition in developing countries, particularly deficiency of vitamin A in poor rice consumers. He traced the development of transgenic Golden Rice (GR) since the last more than 20 years to the more recent development of prototypes with significantly higher levels of β-carotene. The two GR varieties (GR1 and GR2) produced by Syngenta have now been donated to the public sector rice research centers in Asia, including IRRI, for backcrossing programs to integrate the GR trait into Asian-adapted varieties. He also elaborated on the parallel studies to maintain the stability, retention and bioavailability of β-carotene in the GR varieties. The commercialization of GM crops in some countries like China, India and the Philippines and adoption of policies to support GM rice development have helped in promoting acceptance of GR.

The second paper of this session was presented by Prof. Desiree Hautea on "Status and the Way Forward at the Agricultural Biotechnology Support Project II (ABSP II)". ABSP II was set up in the Philippines for project development and delivery of bioengineered crops for developing countries. Prof. Hautea highlighted activities carried out under this project involving product commercialization package (PCP) including product development, regulatory approval process, impact assessment, marketing and distribution, capacity building in licensing of IP, institutional and human capacity building and policy development. This approach ensures that product development is based upon scientifically proven technologies and supported by socioeconomic considerations as well as sound business rationale. During the past five years, ABSP II has helped to advance the development of a number of agri-biotech products in Asia and Africa such as fruit and shoot borer-resistant (FSBR) eggplant and late blight resistant potato in India, Bangladesh and the Philippines; papaya resistant to ring-spot virus in the Philippines and East African Highland; and banana resistant to nematodes in Uganda. Work on FSBR eggplant is currently at the final stages of development for potential commercial release. Various food/feed safety studies are also being carried out in India by the regulatory authority and the results are publicly available (www.envfor.nic.in/divisions/csurv/geac/information_brinjal.htm). Dr. Hautea informed that ABSP II has established global partnerships in product development and commercialization involving private partners such as Monsanto and Mahyco and public partners such as Department of Biotechnology, Government of India (DBT), Indian Council of Agricultural Research (ICAR), Indian universities, Bangladesh Agricultural Research

Institute (BARI), East West Seed, University of Philippines and Philippine Council for Agriculture, Forestry and Natural Resources Research & Development (PCARRD).

Dr. J.L. Karihaloo presented his paper on "Asia-Pacific Consortium on Agricultural Biotechnology" (APCoAB) and its establishment under the initiative of APAARI and FAO. Dr. Karihaloo focused on the activities conducted under the objectives of APCoAB which include:

- To serve as neutral forum for partners engaged in R&D, commercialization, education/learning in agri-biotech and environmental safety in Asia-Pacific region.
- To facilitate and promote public awareness and understanding of IPRs, *sui generis* systems, biosafety, risk assessment, harmonization of regulatory procedures and benefit sharing to address concerns regarding adoption of agri-biotech.
- To facilitate HRD for application of agri-biotechnologies to enhance sustainable agricultural productivity and product quality for both farmer and consumer welfare.

The activities highlighted by Dr. Karihaloo included publication of status reports and success stories on the field level application of conventional and modern biotechnology, promoting public-private partnership, organizing training programs/workshop for scientists of the Asia-Pacific countries, organizing policy dialogues, and conducting expert consultations and brainstorming sessions on issues related to application of biotechnology in agriculture in the developing countries. Dr. Karihaloo detailed the efforts being made by APCoAB in dissemination of web based information (www.apcoab.org) on developments in agri-biotech in the region, compiling database on agricultural biotechnology institutes of Asia-Pacific region and biosafety regulations of Asia-Pacific countries. APCoAB is also working towards forging regional and interregional linkages to better assist developing countries in realizing the benefits of biotechnology for agricultural improvement and farmers' well-being.

Dr Magdy Madkour, Supervisor, Agricultural Genetic Engineering Research Institute presented his paper on "Global and Regional Partnerships in Agriculture Biotechnology Network: The Case of Egypt". The Agricultural Genetic Engineering Research Institute (AGERI) in Egypt was established with a mission to promote agricultural sustainability through the development of biotechnology products that are better performing, resistant to biotic and abiotic stresses and valued by consumers. The transfer of *HVA I*, a drought tolerance gene, into wheat has reduced the dependence on irrigation in Giza from eight to two application. Several public-private partnerships/collaborations have been established to promote application of biotechnology, e.g., between Agrofood and AGERI involving the production of virus free orange-fleshed sweet potato stock plants, and between AGERI and Monsanto involving the development of insect-resistant cotton. An environmentally friendly Bt-based biopesticide has also been commercialized under collaboration between Biogro and AGERI. Dr. Magdy informed that the National Biosafety System in Egypt has established the National and Institutional Biosafety Committees, and has formulated Biosafety Regulations and Guidelines. The Regional Agricultural Biotechnology Network (RABNet) has recently been established under the umbrella of AARINENA (Association of Agricultural Research Institutions in the Near East and North Africa). RABNet comprises four working groups: Omics and Molecular Markers Technology Group; Gene Transfer, Expression & Regulation Group; Biosafety & Intellectual Property Rights Group; and Bioinformatics & Knowledge Management Group. The AARINENA/RABNet has established important collaboration with APAARI and APCoAB.

Session IV: Issues in Adoption and Commercialization of Agricultural Biotechnology–Panel Discussion

This session was chaired by Dr. Gerard Barry, Coordinator, Golden Rice Network, IRRI, and Dr. Ibrahim Hamdan, Executive Secretary, AARINENA. Four lead presentations were made in this session followed by open house discussion.

Prof. Drew L. Kershen, University of Oklahoma, USA made a presentation on "Creating a Conducive Environment for Biotechnology: The Cartagena Protocol as an Enabling Framework". Prof. Kershen emphasized that the Cartagena Protocol on Biosafety (CPB) creates an enabling environment for the environmentally sound application of biotechnology, making it possible to derive maximum benefits that biotechnology has to offer, while minimizing the possible risks to the environment and human health. Although "risk" is mentioned at many places in the CPB, the interpretation in general should lean towards the creation of an enabling environment for application of biotechnology. Biosafety laws in the South-East Asian countries while being in agreements with CPB are not in conflict with the WTO. Existing laws and regulations are in fact sufficient to safeguard human health and the environment, and should be used to resolve issues of labelling, contained use, pharmaceuticals and transit of GM products. Experiences gained through decades of research and commercial use of agricultural biotechnology in some countries should be taken into consideration by other countries while developing new laws on biosafety. Regulatory policies including those on risk assessment should be based on well-founded scientific results and acceptable across countries.

Dr. Raj Paroda, Executive Secretary, APAARI presented his paper on "Public-Private Partnership", wherein be emphasized the need for public and private sector organizations to work together so that the potential of biotechnology is fully realized and the benefits reach the poor farmers and consumers in the developing countries. The strengths of public and private sectors are mutually complementary; public sector having access to rich germplasm and a large pool of trained scientists while private sector has a leading edge in GM technology applications, IPR and regulatory management skills, and marketing networks. Dr. Paroda recounted some successful public-private partnership (PPPs) but felt that such partnership are still in infancy due to several constraints. These include divergent objectives of different sectors, high transaction costs of operationalizing and coordinating the partnerships, mutual mistrust, and negative perceptions. Among the several suggestions made by him, some that are fundamental for making PPPs successful are: (a) the partnership should be based on common goals of the partners to achieve objectives of mutual interest that are also aimed at addressing national needs of increasing productivity and farmers' income; (b) the partners should have matching resources which also complement mutual strengths; (c) the partnership should be built on mutual trust and commitment to create a dynamic results oriented working environment and; (d) the output of the partnership should be more than the potential of individual partners.

Dr. Alda Lerayer, Executive Director, Council of Biotechnology Information presented her talk on "The Use of Biotechnology for Biofuel Production in Brazil". She recalled the events that led to high adoption of GM crops in Brazil where currently 65% of soybean, 50% of cotton and 4% of maize cultivation is GM based. It is intended to raise GM maize production to 90% in 2008. Sugarcane covers an area of 7.0 million ha, of which 3 million ha is used for sugar production and 3 million ha for ethanol production. The use of sugarcane as the raw material for ethanol production is preferred because ethanol from sugarcane requires less energy, is cheaper and more efficient. The energy balance of ethanol produced from sugarcane as experienced in Brazil is 4.5 times better than ethanol produced from sugar beet or wheat, and almost 7 times better than corn ethanol. The sugarcane value chain involves 6.5 million ha, 73 thousand growers

and 390 mills and distilleries. The Brazilian framework supports science, technology and innovation in the bioethanol business and facilitates interactions between academia and private sectors. GM sugarcane varieties developed by Brazilian private and public companies have 40% more sugar and it is expected that in 10 years' time, ethanol productivity will be doubled per hectare. Dr. Lerayer concluded that in Brazil, biotechnology has an important role in sustainable expansion and innovation for competitiveness in ethanol production from sugarcane.

Dr. Victoria Henson-Apollonio from Bioversity International, Central Advisory Services on Intellectual Property, Netherlands made a presentation on "Intellectual Property Rights and Agricultural Biotechnology". Dr. Henson-Apollonio detailed different forms of IPR relevant to biotechnology: patents, plant breeder's rights, trademarks, copyrights, trade secret, confidential information, regulatory dossiers and information about performance. Patent rights have relatively minor importance in domestic product use but could have an important role when export is involved. Some case studies were cited involving "obviousness" test and the need for the gene to be "functional" in order to invoke patent rights. Plant breeder's rights also provide a way to ensure breeder's access to newly protected varieties. Dr. Henson-Apollonio opined that trademarks are underutilised by national organizations but are highly valued by international companies. There is a need to build capacity in patent and contract law and negotiation of agreements.

Following Panel Members' presentations, Mr. M.V.S. Nagi Reddy, Dr. Raj Paroda, Dr. Alda Lerayer, Dr. Ibrahim Hamdan, Dr. Gerard Barry, Prof. Drew Kershen, Dr. Raghunath Ghodake, Prof. Chris Leaver, Mr. Raul Montemayor, Prof. Dr. Wickneswari Ratnam, Mr. Nagulendran, Mr. Khairudin Hashim and Dr. Walter Alhassan participated in general discussion. The points made were:

- Developments in science and technology will resolve problems of food and fuel insufficiency by enhancing crop productivity including that on marginal lands. These technologies will provide opportunities for alternative incomes to farmers.
- A national strategy needs to be developed to take advantage of the available new technologies for crop improvement. The current problem of food shortages is temporary and can be overcome by appropriate use of second-generation technologies. Full harnessing of these technologies by developing countries would require more research, investment and reorientation.
- Adoption of GM crops even on small farm holdings in developing countries like India and Brazil has resulted in improved harvests, reduced pesticide use and higher farmer incomes.
- Biotechnology has considerable relevance in plantation crops which have received less attention so far. In these crops, biotechnology will help in improving yield, and incorporating pest and disease resistance and salinity tolerance.
- While aiming for yield increase, the need for additional inputs that increase the production cost several folds needs to be kept in view. Hence, there is a need to work out the actual energy balance in terms of labour and nutrient inputs while aiming for higher productivity.
- Crop diversification may sometimes affect food security by reducing the availability of food grains. On the other hand, it contributes to expand the overall food basket and helps farmers in increasing their incomes and profitability. A national perspective needs to be developed regarding the overall needs related to food security and farm sustainability. Strategic plans, including the use of biotechnology need to be developed accordingly.
- The use of food crops as biofuels should be viewed in the context of its impact on food availability and affordability. Non-food plants like high cellulose grasses and microalgae offer good substitute as bioenergy sources. Genetic engineering offers opportunities to develop high energy yielding bioresources and efficient conversion of bioproducts into energy.

- There is also a need to address the regulatory, IP and benefit sharing issues. Every country should have institutional establishments relating to legal issues. Developing countries have limited capacity on these aspects and there is a need to build the same.
- Besides public-private partnerships, there is a need to develop and strengthen regional and inter-regional cooperation and partnerships. An enabling environment needs to be created for supporting partnership-building.
- Bilateral and regional modalities need to be developed for exchange of germplasm since availability of diverse germplasm is an essential requirement for crop improvement, including biotechnology. In this regard, APAARI has developed a Material Transfer Agreement for the international exchange of germplasm which may be considered by national agencies for implementation.
- With its experience on Freedom to Operate issues in biotechnology, Department of Biotechnology, Government of India could support other countries which do not have the resources or capacities to do the required analysis and formulate material transfer and IPR agreements. Hopefully, India can become a donor nation in terms of providing such expertise.
- It would be in the larger interest of the society for scientists to activity participate in public forum discussions and meetings to explain the science and impact of biotechnology. Different viewpoints need to be taken into account and apprehensions removed by providing rational, science-based information.
- An effective biosafety regulatory system is desirable since the consumers need to have trust in the system. With such trust, the biotech products will be more acceptable and in turn the farmers will benefit.

Session V: Breakout Group Discussion and Recommendations on Addressing Issues through Country and Regional Initiatives

Four working groups deliberated on specific issues relating to application of biotechnology for promoting food security in developing countries. Food security was discussed in the context of its definition and coverage as provided by the FAO:

- Food security exists when all people, at all times have access to sufficient, safe and nutritious food to meet dietary needs and food preferences for an active and healthy life.
- Food security involves four conditions:
  - Adequacy of food supply or availability;
  - Stability of supply, without fluctuation or shortage from season to season or from year to year;
  - Accessibility to food or affordability;
  - Quality and safety of food.

Group I: Ensuring Food Security

Members

Prof. Chris Leaver (Facilitator)
Mr. Raul Montemayor (Rapporteur)

Prof. Helen Nair
Dr. P.C. Girahagama
Dr. Patcharin Tanya
Mr. M.V.S. Nagi Reddy
Dr. Le Huy Hum
Dr. Wong Wan Cheng

Observations on Definition of Food Security

Following factors were identified as affecting food security:

- Stagnant or declining farm profitability (net margin) due to rising input costs and cheap food policies of governments thus reducing incentives for farmers;
- High farm labor costs;
- Post-harvest losses, transport and marketing costs;
- Calamities and climate change;
- Inefficient marketing systems;
- Weakened extension system;
- Limited land access and land conversion.

Recommendations

- The food crisis is a wake-up call to reform agricultural production and support system.
- Need for technological innovations including biotechnology that improve farming profitability:
  - Reduce farming costs by developing improved crop varieties with high productivity, stress tolerance, pest resistance and better utilization of nutrients;
  - Improved product value.
- Need for closer farmer-scientist linkages and cooperation.
- Need for policy changes and programs that:
  - Improve farming profitability;
  - Reduce risks faced by farmers;
  - Preserve biodiversity;
  - Educate and orient consumers.
- Society must pay the price for food security by recognizing value of food and reducing food wastage.

Group II: Public Perception and Awareness Generation

Members

Prof. Bruce Chassy (Facilitator)
Dr. Gerard Barry (Rapporteur)
Dr. Victoria Henson-Apollonio
Dr. Alda Lerayer

Ms. Mahaletchumy Arujanan
Dr. Umi Kalsom Abu Bakar

Observations on Definition of Food Security

- Food security means different things to different people. Some perceive intensive agriculture as not sustainable and farming as damage to the environment. Others perceive organic farming as the only sustainable agriculture.
- Public perceptions are formed by people who have done their homework and thought strategically. Scientists have often been *ad hoc* and communication has been an afterthought, defensive and adversarial.
- Scientists have played into hands of someone else's strategic plans who have framed the debate and defined the terms while the scientists have been reactive.
- Scientists have credibility but are undermined by activists. Agriculture scientists are perceived to be pro-industry especially if they receive any industry funding.

Recommendations

- There is a need to create a balanced public perception about biotechnology using diverse communication tools and approaches.
- Audiences:
  - High school;
  - General public, in an out of education settings;
  - Supermarkets;
  - Consumer groups;
  - Civil servants;
  - Media and journalists;
  - Farmer and civil society organizations;
  - Need to fine-tune the approach for different countries.
- Need the trusted communicators:
  - Doctors, nutritionists, dieticians, leaders in rural and farm communities, various ministries.
- Scientists as communicators:
  - Need to be trained as communicators in science;
  - Communication not just on biotechnology but on diverse issues of agriculture, food security, environment and science;
  - Science should be back into science classes.
- Need for professionally trained well staffed communication units.

Group III: Regulatory Management

Members

Dr. Drew Kershen (Facilitator)
Dr. Villasini Pillai (Rapporteur)
Dr. Anita Anthonysamy

Dr. Habibuddin Hashim
Dr. Wee Chien Yeong
Datin Paduka Prof. Dr. Khatijah Yusof
Dr. Marzukhi Hashim
Ms. Juanita Joseph
Dr. Lam Peng Fatt
Mr. Razif Abdul Aziz

Observations on Definition of Food Security

The groups added one more condition to food security: Acceptability in a multi-cultural and religiously diverse society.

To ensure food security in Malaysia, three priority-wise approaches were proposed:

- Ensuring high per unit yields on the existing cultivated areas;
- Enlarging the acreage by expanding cultivable area;
- Food import as a back-up.

Recommendations

- Facilitating regulatory management is essential to fully harness the benefits of biotechnology and effectively utilize it to promote food security in developing countries. Following specific actions were recommended in this regard:
  - Simplified regulatory norms for GM food crops and traits of apparently limited environmental and human risk;
  - Facilitate transboundary movement of GM food crops through bilateral or regional agreements on biosafety information requirement and acceptance;
  - Capacity building in developing countries in the areas of scientific risk assessment and management;
  - Facilitate trade in GM products and harmonization of relevant laws.

Group IV: Promoting Public Investment and Partnership Building: South-South Linkages

Members

Dr. Magdy Madkour (Facilitator)
Dr. P. Ananda Kumar (Rapporteur)
Dr. Ibrahim Hamdan
Dr. Raghunath Ghodake
Dr. Rakesh Kapila
Dr. Francis Ogbonnaya
Ms. Teh Guat Hong
Dr. Walter Alhassan
Dr. Zamri Ishak

Ms. Norzihan Abdullah
Prof. Dr. Wickneswari Ratnam

Observations on Definition of Food Security

To achieve the objective of food security there is a need for active South-South collaboration in the area of agricultural biotechnology. Further, food security is achievable only by affordability, in other words enhancing purchasing power of consumers. Governments should play an important role in controlling food prices thus making food accessible to poor.

Recommendations

- South-South linkages can help in promoting agricultural biotechnology in developing countries. The genetic resources are very abundant and rich in countries of the South while the tools and the techniques are available in North. However, South has made significant progress in recent years and there is a need to exchange information, germplasm and technologies by collaborating with each other.
- One of the mechanisms is to conduct workshops and define the available resources and needs. Besides electronic mode of interaction, direct human interface is more effective.
- Identification of priorities, objectives and the definition of the current status are important.
- APAARI website can list out these resources and needs which would facilitate such interaction.
- The existing fora such as APAARI, FARA and AARINENA should facilitate South-South interaction while networks already functional within these platforms can play a major role in information and technology exchange and capacity building. Interregional INCANA-Bt cotton network (APAARI, CACAARI and AARINENA) is an example that can be followed in respect of other crops and commodities including agricultural biotechnology.
- The capacity of the public research systems in several countries of the South, especially Pacific island countries, is weak and can be strengthened by cooperation, capacity building and technology transfer. Strong government support is also needed in such instances.
- The transgenic technologies already available in the South and the successes achieved can be exchanged through well worked out agreements and networks. APAARI can facilitate such exchanges.
- Already established technologies that need upscaling can also be given special attention in these exchanges.
- Public sector investment in basic and strategic research in agricultural biotechnology is very important.
- Creation of conducive environment in public sector is important to absorb and devolve the technologies generated by private sector.
- Networks emphasizing on the staple crops such as cassava, sweet potato and cowpea farmed by resource poor farmers need to be established.
- Strong interaction and collaboration with CGIAR centers located in countries of the South is extremely important to bring about both global and regional dimensions to the collaboration.
- Creation of an enabling environment to promote public-private and public-public partnerships in South is imperative. This would also encourage investment by private sector.
- Successful South-South partnerships would facilitate policy makers in taking more proactive steps to promote agricultural biotechnology.

Session VI: Plenary Session–Presentation of Group Recommendations and Discussion on General Recommendations

The Plenary session was chaired by Dr. Raghunath Ghodake and Dr. Umi Kalsom Abu Bakar. Recommendations made by the four Breakout Groups were presented and following additional recommendations were made:

Ensuring Food Security

- Biotechnology is a powerful tool to achieve the goal of food security. However, biotechnology on its own will not be sufficient to solve the present food crisis. Shortage of land and water, severe climatic changes including flooding and drought contribute significantly to food security problem.
- Other factors such as education and social issues also impinge on food security.

Public Perception and Awareness Generation

- It is important to educate school children about biotechnology and GM crops in a holistic manner since some agencies are propagating only their negative aspects.
- APAARI may help in developing strategic plans to introduce awareness programs at school level.

Regulatory Management

- There is a need to support some countries in adopting a balanced regulatory approach to GM technology. Such countries can gain from the experiences of India, China and the Philippines in developing confidence in the technology and adopting a science-based regulatory management approach.
- Efforts should be made to harmonize public willingness to accept GM crops with the regulatory laws. This will facilitate achieving food security.
- APAARI should initiate meetings/workshops with the policy makers on regulatory management issues.

Promoting Public Investment and Partnership Building: South-South Linkages

- In addition to the South-South linkages, there is need to forge North-South collaboration to benefit from advanced technologies and new materials. The experience of MARDI which has established good networking using ISAAA to link with research groups from five countries of the North and South could serve as a good example.
- Some international organizations and science societies could be approached to support international collaborations and capacity building. Royal Science Society, ACP (African Caribbean Pacific group of states) and APEC and also the private sector (major multinational companies) can be sources of such support. Details of international bodies that fund collaborations with developing countries can be found at the website: www.icsu.com.

General Recommendations

The participants of the Expert Consultation expressed general consensus that biotechnology provides powerful tools to increase and diversify agricultural production. However, there is a need to make wide-ranging reforms in the agricultural production systems to fully address the issues of food security in the developing countries.

Following general recommendations with particular reference to application of biotechnology in agriculture were adopted:

(i) Strengthening biotechnology for food security and profitability of farmers

- Experiences in several countries including India, China and the Philippines where adoption of GM crops has resulted in increased crop yields and higher net profits to farmers indicate the potential of biotechnology in meeting the goals of food security. Other countries need to adopt appropriate policies and strategies to encourage adoption of biotechnology in agriculture.
- There is a need to adopt appropriate biotechnological tools (GM technology, marker-aided-selection, genomics, micropropagation, diagnostics) to address specific scientific issues related to crop improvement and diversification. The objective should be to increase productivity in conventional crops as also help in crop diversification by developing varieties having biotic and abiotic stress resistance that can be grown on marginal lands.
- Emphasis should be placed on improving nutritional quality of food crops, being an important component of food security. As exemplified by Golden Rice, biotechnology has an important role in achieving this objective.
- There is a need for policy changes and programs that improve farming profitability, reduce risks faced by farmers, preserve biodiversity, and educate and orient consumers.
- Biotechnology provides opportunities to develop alternatives to food crops for biofuel production. Non-food crops like cellulosic grasses and microalgae need biotechnological interventions to render their use for biofuel production economically viable.

(ii) Facilitating regulatory management

- Regulatory issues impact adoption, commercialization and transboundary movement of GM crops and products. Hence, facilitating regulatory management would help in rapid dissemination of useful products to meet agriculture and food security needs across countries. Three specific recommendations to facilitate regulatory management were made:
- Build confidence in GM technology which will facilitate a more open and acceptable regulatory system.
- Simplify regulatory norms for GM food crops and traits of apparently limited environmental and human risk.
- Facilitate transboundary movement of GM food crops through bilateral or regional agreements on biosafety information requirement and acceptance.

(iii) Strengthen linkages

South-South linkages

- South-South linkages will help in promoting agricultural biotechnology among developing countries and bridge regional and interregional gaps. There is a need to exchange information, germplasm and technologies through South-South collaborations. This can be done through:
  - Conducting workshops and defining the available resources and needs, followed by mutually agreed action plans.
  - The existing fora such as APAARI, FARA, AARINENA and other networks already functional within these platforms can play a major role in facilitating South-South interaction.

North-South linkages

- The genetic resources are abundant in countries of the South while the tools and technologies are available in North. North-South linkages for germplasm, technology, products and information exchange will be of mutual benefit and help the developing countries to accelerate the pace of biotechnology adoption.

Public-Private linkages

- The strengths of public and private sectors are mutually complementary. There is a need for the two to work together with mutual trust and commitment to create a dynamic and result oriented working environment.

(iv) Creating awareness by improving communication

- Train young scientists as communicators, not just in the field of biotechnology but also on issues of agriculture, food security and environmental safety.
- APAARI should initiate organization of meetings/workshops with the policy makers in the Asia-Pacific region on food security, biotechnology and regulatory management issues.
- Arrange discussions between scientist, CSOs, farmer organizations and consumer groups to foster understanding and cooperation between all stakeholders.
- Develop farmer-scientist linkages and cooperation through conducting field visits, seminars etc.
- Set up scientific academia and communication units at the national level to assist in awareness creation.

(v) Creating awareness through education

- Include biotechnology in school syllabi providing factual information about its usefulness and safety aspects. APAARI may come up with a strategic plan to introduce such a program in schools.
- Develop educational tools including websites on GM technology, safety of GM crops, IP and regulatory systems.

(vi) Capacity building

- Need to strengthen capacity in developing countries especially in the area of scientific risk assessment and management and on IP issues.
- Collaborate in regional and interregional capacity building through support of NARS, CG centers and fora like APAARI, FARA and AARINENA.
- Need to raise funding for capacity building through international bodies such as the ACP (African Caribbean Pacific group of states), APEC, Royal Science Society and also private sector (major multinational companies).

In his concluding remarks, Dr. Ghodake mentioned that a number of issues were brought up which have provided APAARI and MARDI important leads to develop appropriate strategies and action plans.

Closing Ceremony

Dr. Raj Paroda summed up major recommendations and presented his closing remarks. Dr. J.L. Karihaloo and Dr. Umi Kalsom Abu Bakar offered vote of thanks.

PROGRAM

AUGUST 20, 2008 (Wednesday)

08:00-09:00	**Registration**	
09:00-10:00	**Opening Ceremony**	
	Welcome Address	Datuk Dr. Abd. Shukor Abd. Rahman
	Welcome Address	Dr. Raghunath Ghodake
	Opening Speech	HE Dato' Mustapa Mohamed, Minister of Agriculture and Agro-based Industry, Malaysia
	Release of Publications	
10:00-10:45	**Group Photograph and Tea Break**	
10:00:11:30	**Minister's Press Conference**	
Session IA:	**Status of Agricultural Biotechnology Research and Application – Global Developments** Chair: Dr. Raj Paroda Co-chair: Mr. Ariffin Tawang	
10:45-11:15	Recent Research Advances in Agricultural Biotechnology	Prof. Bruce Chassy
11:15-11:45	Global Status on Adoption of GM Crops	Dr. Randy Hautea
11:45-12:15	Adoption of GM Crops for Food Security	Prof. Chris Leaver
Session IB:	**Status of Agricultural Biotechnology Research and Application – Country Reports** Chair: Datuk Dr. Abd Shukor Abd Rahman Co-Chair: Dr. Raghunath Ghodake	
12:15-12:35	Status and Development of Biotechnology in Malaysia	Dr. Umi Kalsom Abu Bakar
12:35-12:55	Status and Development of Biotechnology in Vietnam	Dr. Le Huy Hum
12:55-14:00	Lunch	
14:00-14:20	Status and Development of Biotechnology in India	Dr. P. Ananda Kumar
14:20-14:40	Status and Development of Biotechnology in Thailand	Dr. Patcharin Tanya
14:40-15:00	Status and Development of Agricultural Biotechnology and Biosafety in West Asia and North Africa	Dr. Ibrahim Hamdan

15:00-15:20	Status and Development of Agricultural Biotechnology in Africa	Prof. Walter Alhassan

Session II: Biotechnology Applications
Chair: Dr. Randy Hautea
Co-chair: Dr. Umi Kalsom Abu Bakar

15:20-15:40	Biofortification to Enhance Quality of Food Crops	Dr. Gerard Barry
15:40-16:00	Marker Aided Selection for Crop Improvement	Dr. Francis Ogbonnaya
16:00-16:20	Biotechnology for Production of High Quality Disease Free Planting Material	Dr. Yen Yung-Fu
16:20-16:40	Biotechnology in Germplasm Evaluation and Conservation	Dr. Takuji Sasaki
16:40-17:00	Genetic Enhancement through Biotechnology in Rice	Dr. Darshan Brar
17:00	Tea	
18:00	Reception Dinner	

AUGUST 21, 2008 (Thursday)

Session III: Global and Regional Partnerships in Agricultural Biotechnology
Chair: Prof. Bruce Chassy
Co-chair: Dr. Hassan Mat Daud

09:00-09:30	Golden Rice	Dr. Gerard Barry
09:30-10:00	Status and the Way Forward at ABSP II	Dr. Desiree Hautea
10:00-10:30	Status and the Way Forward at APCoAB	Dr. J.L. Karihaloo
10:30-11:00	Tea Break	
11:00-11:30	Global and Regional Partnerships in Agriculture Biotechnology Network	Dr. Magdy Madkour

Session IV: Issues in Adoption and Commercialization of Agricultural Biotechnology– Panel Discussion
Chair: Dr. Gerard Barry
Co-chair: Dr. Ibrahim Hamdan

Lead Presentations:

11:30-12:15	Regulatory Management	Prof. Drew Kershen
12:15-12:45	Public-Private Partnership	Dr. Raj Paroda
12:45-14:00	Lunch	
14:00-14:30	Use of Biotechnology for Biofuel Production in Brazil	Dr. Alda Lerayer
14:30-15:00	Intellectual Property Rights in Agricultural Biotechnology	Dr. Victoria Henson-Apollonio

Panel Discussion:

15:00-17:00 Moderators: Dr. Gerard Barry & Dr. Ibrahim Hamdan

17:00 Tea

AUGUST 22, 2008 (Friday)

Session V: Break Out Group Discussion and Recommendations on Addressing Issues through Country and Regional Initiatives

09:00-10:30	Group I : Ensuring Food Security	Facilitator: Prof. Chris Leaver
	Group II : Facilitating Regulatory Management	Facilitator: Prof. Drew Kershen
	Group III : Public Perception and Awareness Generation	Facilitator: Prof. Bruce Chassy
	Group IV : Promoting Public Investment and Partnership Building: South-South Linkages	Facilitator: Dr. Magdy Madkour
0900-10:30	Group Discussion	
10:30-11:00	Tea Break	

Session VI: Plenary Session

Chair: Dr. Raghunath Ghodake

Co-chair: Dr. Umi Kalsom Abu Bakar

11:00-13:00 Presentation of Group Recommendations and Discussion on General Recommendations

13:00-13:30 **Closing Ceremony**

13:30 Lunch and Field Trip to Malaysian Agriculture, Horticulture and Agro-tourism (MAHA) Exposition 2008 at Malaysian Agriculture Exposition Park, Serdang (MAEPS)

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