

Mashelkar Foreign Associate of US National Academy of Sciences



R. A. Mashelkar, Director General, Council of Scientific and Industrial Research and President, Indian National Science Academy has been elected as a Foreign Associate

of the US National Academy of Sciences.

Mashelkar has made path-breaking contributions in transport phenomena and thermodynamics of stimuli-responsive gels, modelling of polymerization reactors, and engineering analysis of non-New-

tonian flows. He made the first molecular level interpretation of volume phase transitions in gels, designed unique biomimetic switching hydrogels and discovered novel macroscopic self-organization and self-healing phenomena.

Trieste Science Prize for T. V. Ramakrishnan



Tiruppattur V. Ramakrishnan, DAE Homi Bhabha Professor of Physics, Banaras Hindu University in Varanasi, India, and Sergio Henrique

Ferreira, Professor of Pharmacology in the Faculty of Medicine at the University of São Paulo in Ribeirão Preto, Brazil, will each receive a cash prize of US \$50,000. Ramakrishnan won in the category of physics and astronomy and Ferreira in the category of biological sciences.

The Trieste Science Prize, administered by the Academy of Sciences for the Developing World (TWAS) and funded by illycaffè s.p.a., is designed to give inter-

national recognition and visibility to outstanding scientific achievements made by scientists living and working in the developing world.

Ramakrishnan, with his colleague Mohamed Yussouff, has provided the theoretical underpinnings for studying solids as atomically 'frozen' versions of dense liquids characterized by strong correlations of subatomic particles that have become even stronger. This insight, which has enabled scientists to better understand how classical dense systems are altered, has had a profound impact on scientific investigations into quantum transport, nanoscopic systems, and metal-insulator transitions. Ramakrishnan is currently the President of Indian Academy of Sciences, Bangalore.

Ferreira, who began his career analysing the analgesic effects associated with the venom of the Brazilian snake *Bothrops jararaca*, has shown how enzymes produce chemical inhibitors that can ease high blood pressure and block sensitivity towards pain. His findings, which have captured the attention of such international pharmaceutical firms as Squibb, have helped lay the scientific foundation for the treatment of hypertension and chronic pain.

The Trieste Science prize is named for the city of Trieste, home to TWAS, the Abdus Salam International Centre for Theoretical Physics (ICTP) and other international scientific institutions that have played a critical role in the promotion of science in the developing world.

Honour for Mehta



Goverdhan Mehta, Professor of Organic Chemistry and Director, Indian Institute of Science, Bangalore has been elec-

ted to the Fellowship of the Royal Society in recognition of his wide ranging contributions to the synthesis of natural products. Mehta is the President of the In-

ternational Council of Scientific Unions and a former President of the Indian National Science Academy, New Delhi.

MEETING REPORT

Transgenic plants with dual *Bt* gene – An innovative initiative for sustainable management of *Brassica* insect pests*

A stakeholder workshop in New Delhi on sustainable solutions to *Brassica* pest pro-

*A report on the workshop on 'Public-Private Partnership in the Use of Agribiotech for Sustainable Solutions to *Brassica* Pest Problems', organized by AVRDC – The World Vegetable Center, Taiwan and the Asia-Pacific Consortium on Agricultural Biotechnology, Bangkok and held on 10 February 2005 at Claridges Hotel, New Delhi.

blems was inaugurated by Gautam Kalloo (Deputy Director General, Indian Council of Agricultural Research (ICAR), New Delhi). Participants were drawn from the environmental, regulatory, research and end-user communities in India and included representatives of the private-sector seed industry. Emphasizing the need for the best use of biotechnology to produce more vegetables with less pesticide, Kalloo stated that the use of biotechnology for

management of pests of *Brassica* is appropriate at this time and that gene pyramiding is a major current drive of ICAR. Biotechnology should be used in an integrated mode, not in a stand-alone mode, ensuring environmental and human health safety in intensive pesticide use areas. Vegetables with 'dual genes' should be developed and issues related to gene pyramiding need to be resolved to make the dual gene varieties effective and compatible in an

integrated pest management (IPM) system. Explaining the purpose of the workshop, Thomas A. Lumpkin (Director-General, AVRDC – The World Vegetable Center, Taiwan) indicated that transgenic technology is having significant impacts on the growing sector. Transgenic plants with dual genes having different target sites within the insect have been developed now. Scientific, technological, biosafety and ethical concerns arising out of dual gene technologies need to be addressed.

O. P. Dubey (ICAR), speaking on 'Crucifer pest problems: Current pest control practices, financial, environmental and social costs', emphasized that the number of pest species in crucifers has increased to 38 from 10 in the 1920s, despite the use of resistant plant varieties, pheromone traps, biological control agents and selective use of pesticides. Though the national pesticide consumption went down to 43,584 mt in 2000–01 from 75,033 mt in 1990–91, pesticide residues are still a major problem in vegetable exports, with about 12% of vegetables reaching the market having residues over the maximum residue level (MRL), due to use of sub-standard pesticides, wrong advice and supply of pesticides to farmers by pesticide dealers, indiscriminate pesticide use and non-observance of waiting periods before marketing IPM techniques, which can sometimes be successful in reducing use of pesticides to a necessary minimum, have failed to gain significant uptake in vegetable production at the village level in India; currently they lack the political backing necessary to make them effective at block and district levels. Pesticide residues are a serious threat to the export of cruciferous vegetables like cabbage and cauliflower, for which India is the second and the first largest producer respectively, in the world. Emphasizing the current status of vegetable IPM in India and the use of *Bacillus thuringiensis* (*Bt*) in vegetable pest management, T. P. Trivedi (National Centre for Integrated Pest Management (NCIPM), New Delhi) described creation of visible impact by use of eco-friendly IPM techniques on crop productivity and environment. This is the current mission of NCIPM, which has successfully implemented an IPM in areas of Uttar Pradesh, Jharkhand and Karnataka in tomato and cabbage utilizing pongamia oil, neem oil, *Bt*-based pesticides and trap crops. However, the area of Indian agriculture under IPM has not surpassed 5% due to lack of availability of quality in-

puts, and differing individual approaches in dissemination of technology. Addressing the low adoption rates and poor linkage between research and extension agencies is considered to be a major thrust programme now. Seed was emphasized as a most important component in IPM as it attracts the farmers due to ease of adoption.

Speaking on development of 'dual gene' concept for management of resistance in crucifers, Anthony M. Shelton (Cornell University, USA) emphasized that, in practice, the time taken for resistance development in insects to transgenic plants (not yet seen in the field) has already exceeded the time for resistance to most of the conventional insecticides. Resistance management strategies are being built based on theoretical and empirical studies on resistance management for conventional insecticides, but there is a lot to be learnt about resistance to transgenic crops. Possible deployment strategies to delay the onset of insect resistance to transgenic plants include gene strategies (single/multiple), gene promoter strategies (constitutive, tissue-specific/inducible), gene expression modifications (high dose/low dose) and field tactics (mosaic/mixed plantings of varieties with different genes, spatial and temporal gene rotation). Transgenic plants with 'dual genes' producing toxins with different target sites have the benefit that individual insects naturally resistant to both genes would be extremely rare, resulting in low survival in the crop, which allows a much reduced refuge area. Experiments showed that the impact on delaying the development of resistance of a 30–40% refuge area for a single gene is the equivalent of only 5–10% refuge area in dual gene situations, with dual gene plants delaying the onset of resistance in insects. In experimental work in USA, the rate of increase in resistance to dual gene *Bt* broccoli was significantly lower than that in single gene plants even after 27 generations of selection of the insect pest, diamondback moth (DBM) *Plutella xylostella*. Thoughtful selection of *Bt* genes to have different binding sites in the insect, tight linkage of *Bt* genes to prevent their separation, proactive resistance management programme with regular monitoring, using pyramided *Bt* plants within an overall IPM programme and continued refinement of the use of *Bt* within the IPM strategy are the basics needed for a sustainable control system.

Briefing the workshop on the funded project on 'Risk assessment and management options for stacked gene transgenic crucifers in India and Indonesia', in which Indian Agricultural Research Institute (IARI), New Delhi is the major Indian partner, Derek Russell (Natural Resources Institute, UK and LaTrobe University, Australia) stated that this project will assess the efficacy of dual gene *Brassica* plants against major lepidopterans and non-target organisms, understand the current levels of resistance in insects to the genes of interest, develop strategies to minimize the resistance risks and to explore the potential risks and benefits to farmers and consumers. Though the dual gene *Brassica* plants are expected to control the DBM, the efficacy beyond DBM on other key pests of *Brassica* such as the lepidopterans *Crocidolomia binotalis* and *Hellula undalis* will be explored.

Discussing the experience with human health profile of *Bt* worldwide, Bruce M. Chassy (University of Illinois, USA) indicated that safety of the source organism or food from which the gene comes, history of the safe use or exposure, safety of DNA ingestion, safety of antibiotic resistance marker, potential for toxicity or allergenicity, retention of nutritional value, equivalence of composition, absence of unintended effects and estimation of dietary intake are the key issues in hazard identification and risk characterization, while assessing the food safety of biotech crops. About 200 commercial products containing whole viable cells of *Bt* are being marketed after passing stringent regulatory requirements for safety and efficacy in several countries. It has been safely used for the past five decades. Transgenic plants with *Bt* genes have been planted over large areas for the past ten years without any confirmed human health problems, which indicates the safety of *Bt* genes and their products. The US Environmental Protection Agency has confirmed the safety of transgenic plants containing two or more *Bt* genes.

T. V. Ramanaiah (Department of Biotechnology, New Delhi) explored the legal aspects of registration of transgenic plants in India. Genetically modified organisms are regulated in India under the Indian Environment (Protection) Act of 1986. The 1989 'Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Microorganisms, Genetically Engineered Organisms or Cells' constitute the legally binding regulatory framework

for genetically modified organisms in India. As required by the 1989 Rules, biosafety guidelines were first issued by the Department of Biotechnology under the Ministry of Science and Technology in 1990. These guidelines were revised and expanded in 1994 and 1998. Ramanaiah spoke on the roles and responsibilities of various committees, such as the Recombinant DNA Advisory Committee, the Review Committee on Genetic Manipulation, the Institutional Biosafety Committee, the Genetic Engineering Approval Committee, the State Biotechnology Co-ordination Committee, District Level Committees and the Monitoring cum Evaluation Committee in regulating research involving genetically modified organisms, as well as genetic transformations of green plants rDNA technology in vaccine development, and large-scale production and deliberate/accidental release into the environment of organisms, plants, animals and products derived from rDNA technology. Genetically modified (GM) plants containing *Bt* genes follow the same procedure; there are no additional or specific needs for registration of *Bt* genes.

K. V. Prabhu (IARI), speaking on 'Environmental perspective; Bio-confinement and out-crossing problem in *Brassicac*', emphasized that the gene flow through volunteer plants and unintended off-type mixing would be the key issues in transgenic plants, which might lead to creation of new weeds, evolution of new crop pests, invasion of natural habitats and loss of biodiversity. However, this could be prevented or significantly delayed by adopting proper isolation distances, induced sterilization, cross-incompatibility, fitness reduction in transgenic plants and using extranuclear transformations. There are no reports yet of outcrossing between *Bt* transgenic plants and non-*Bt* plants in *Brassicac* under natural conditions nor of increased competitiveness or the creation of increased weediness.

Sachin Chaturvedi (Research and Information System for the Non-Aligned and Other Developing Countries, New Delhi) highlighted the importance of public perception and consumer views for any commercialization of *Bt* transgenic vegetables. Consumer preferences could play a significant role in the future of transgenic vegetables. Stakeholder research should be designed to study the risks and

benefits of transgenic vegetables on farmers and producers in such a way as to ensure that the results are useable by policy makers, scientists and non-governmental organizations.

Transgenic plants which produce insecticidal proteins are reducing the cost of plant protection, according to P. Chengal Reddy (Federation of Andhra Pradesh Farmers' Association, Hyderabad). Though (on the model of *Bt* cotton) the transgenic seed cost is comparatively expensive for the resource-poor farmers who occupy nearly 50% of Indian agriculture, pesticide costs are far more significant than seed costs. This has encouraged farmers to adopt legal/illegal transgenic cotton plants containing *Bt* genes. He mentioned that farmers are willing to pay higher price for the seeds provided that the added value is clear and fairly shared between the breeder and the farmer. He also mentioned that, provided this is the case, farmers are not so eager to grow their own seed, as they have small holdings which they would rather use for food and feed production. They are fast in adopting new varieties, if found far better. As transgenic technology is a high-level technology and there is lack of adequate knowledge amongst farmers due to the low level of extension training, a gradual introduction is needed to allow time for proper integration into Indian agrarian situations.

Given the high cost of developing and gaining approval for GM solutions in agriculture and the need for this technology to be available to the poorest farmers, Orlando de Ponti (Director R&D, Nunhems Vegetable Seeds, The Netherlands) emphasized the need to build a public-private partnership consortium for development, testing and registration of plants with the dual gene system as part of a sustainable solution to *Brassicac* pest problems. He indicated that a public-private partnership would set an example for the biotech/seed industry on how to deal with genetically modified organism projects for orphan crops. The private partner would take the lead in developing the resistant plant material, while public partners would have an important role in testing the suitability of the GM material for release and take the lead in developing an IPM setting. Cooperation with national partners in proving the food and environmental

safety of the material is essential for creating trust and enabling capacity building. The developed germplasm would be passed onto public-sector ownership for dissemination and use by other breeders and small-scale farmers. Engaging the public-sector would lead to creation of a genuine sense of ownership and allow the resistant transgenic plant material to be available for further breeding.

The participants of the workshop concluded that control of lepidopteran pests of *Brassicac* is an increasing problem. It is desirable to minimize the overuse of environmentally damaging pesticides for health and economic reasons. Existing IPM programmes are making significant progress, particularly in highland cropping systems, while *Bt* plants could be useful as one component of IPM systems in certain situations. Using *Bt* toxins in plants in a single gene setting is unlikely to be sustainable, as the insect may overcome the plant resistance quite rapidly. Producing stacked gene *Bt* plant *Brassicac* material requires a public-private partnership because the development and regulatory cost makes it uneconomic for any one commercial organization, and without a public-private partnership, the benefits will not be quickly and cheaply available to small-scale, resource poor farmers. The meeting recommended that a public-private partnership be set up to explore the feasibility of the development, assessment and commercialization of dual gene *Brassicac*, with Nunhems Seeds as the private partner undertaking the development and the public sector partners ensuring that appropriate attention was paid to the environmental, regulatory and social acceptability and equitability aspects of the concept. Kalloo concluded the technical sessions by affirming the commitment of the Indian public sector organizations to this approach.

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