

Dynamics of Agricultural Biotechnology

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A S Chandel and R M Kamal



SAARC Agricultural Information Centre (SAIC)

**SAARC Agricultural Information Centre (SAIC)
BARC Complex, Farmgate, Dhaka 1215, Bangladesh**

Published : 1995

Cover design : Mafruha Begum

**Price : US\$ 10.00 for SAARC countries
US\$ 15.00 for other countries**

Chandel, A S and Kamal, R M

Dynamics of agricultural biotechnology: SAARC bibliographical database. Dhaka: SAARC Agricultural Information Centre, 1995.

ii, 321, liii p.

1. Biotechnology, bibliography. 2. Agricultural biotechnology, bibliography. 3. SAARC Agricultural Information Centre. i. Jt. Author. ii. Title.

Published by : Director, SAARC Agricultural Information Centre (SAIC)

Printed at : Panir Printers, 9 Nilkhet, Dhaka 1205

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GENERAL BIOTECHNOLOGY

1 Biotechnology applications in agriculture in Asia and the Pacific. *Report of an APO Study Meeting.* (Tokyo: 1994: January 18-28). Asian Productivity Organization, Tokyo.

The book contains 17 country papers from Asia and the Pacific presented at the study meeting on biotechnology applications in agriculture organized by Asian Productivity Organisation (APO) and hosted by Government of Japan in Tokyo in addition to 5 resource papers. The papers review the current situation of biotechnology application in the respective country. Resource papers mainly highlight the agricultural biotechnology application in host countries.

2 Biotechnology revolution and the Third World: challenges and policy options. RIS, 40-B, Lodhi Estate, New Delhi. 451 p.

Biotechnologies can prove invaluable to developing countries in their efforts to become more self reliant. However, emerging trends in biotechnology research suggest that relevant biotechnologies may not be easily accessible to the Third World and may instead be used to substitute several of their export commodities. Thus, the biotechnology revolution presents a challenge for developing countries and international organizations to take appropriate policy measures to secure the development potential of new technologies and to combat their adverse effects. The 18 contributions in this volume critically examine the nature of these challenges and suggest policy imperatives. Part 1 highlights the potential of biotechnologies for developing countries in different areas. Part 2 deals with various issues of concern arising from the emerging trends in the global biotechnology industry. Part 3 proposes the policy options and strategies for the international community.

3 AHMED, I. 1991. Biotechnology and rural labour absorption. *Biotechnologies in perspectives*/edited by Albert Sasson and Vivien Costarini. Paris: Unesco, p. 57-72.

The chapter discusses the impact of biotechnologies on productivity and labour absorption and input, structural composition of rural development, plant genetic engineering and job creation. Concludes that biotechnology application lead to massive displacement of hired labour and further research should be directed to identifying policies and measures which will promote development of biotechnologies which responds to specific socio-economic needs.

4 AHUJA, MR. 1986. Perspectives in plant biotechnology. *Current Science*, 55: 5, 217-224; 44 ref.

The current status of in vitro techniques in plant improvement is reviewed under the headings (1) micropropagation, (2) somaclonal variation, (3) production of virus-free plants, (4) haploidy, (5) preservation of germplasm, (6) early selection tests, (7) secondary products, (8) somatic hybridization and (9) genetic engineering.

5 ALI, M. 1994. Status of biotechnological research in the Institute of Postgraduate Studies in Agriculture. *Workshop on Present Status and Future Direction of Biotechnological Research in Bangladesh.* (Dhaka: 1994: June 25).

6 BAJAJ, YPS. 1988. Biotechnology in agriculture and forestry 6. Crops II. Berlin: Springer-Verlag, 578 p.

This volume comprises 31 chapters and deals with in vitro approaches to crop improvement in various fruits, vegetables, grasses and pasture crops. The book is divided into 3 sections: (1) fruits (grape, strawberry, blackberry, raspberry, currants, gooseberry, *Actinidia chinensis*, blueberry and cranberry), (2) vegetables (cauliflower, cabbage, Brussels sprout, cucumber, chicory, *Colocasia esculenta*, rhubarb, lettuce, spinach and quinoa), and (3) grasses and forage and pasture crops (*Festuca arundinacea*, *Bromus inermis*, *Andropogon gerardii*, *Schizachyrium scoparium*, *Sorghastrum nutans*, *Cynodon dactylon*, *Pennisetum spp.*, *Thalassia testudinum*, *Echinochloa spp.* Kale, *Lotus corniculatus*, *Coronilla varia* and *Onobrychis viciifolia*). Also included are brief details of the importance, distribution, diseases and conventional breeding and propagation methods for each crop.

7 BANIK, RL. 1994. A report on the present status and future direction of biotechnology research in the Bangladesh Forest Research Institute, Chittagong. *Workshop on Present Status and Future Direction of Biotechnological Research in Bangladesh.* (BARC, Dhaka: 1994: June 25).

8 BHARGAVA, PM; CHAKRABARTI, C. 1991. Implications of the use of biotechnologies in developing countries. *Biotechnologies in perspective*/edited by Albert Sasson and Vivien Costarini. Paris: Unesco, p. 15-18.

9 BHATTACHARYYA, BC. 1993. **Evolutionary Operation (EVOP) to optimize three dimensional biological experiments.** *Biotechnology and Bio-engineering*, 41: 67-71.

10 BHOJWANI, SS; RAZDAN, MK. 1983. **Plant tissue culture: theory and practice.** Amsterdam, Netherlands: Elsevier Science Publishers, 502 p.

This book is No.5 in the series Developments in Crop Science and contains the following chapters: introductory history; laboratory requirements and general techniques; tissue culture media; cell culture; cellular totipotency; somatic embryogenesis; haploid production; triploid production; cytogenetic studies; in vitro pollination; zygotic embryo culture; protoplast isolation and culture; somatic hybridization; production of pathogen free plants; clonal propagation; germplasm storage.

11 BHUIYAN, M SAFIUL ALAM. 1994. **Current status and future prospects of biotechnology research in Bangladesh Agricultural Research Institute.** *Biotechnology Workshop*. (Gazipur: 1994: 25 Jun). Bangladesh Agricultural Research Institute, Gazipur.

12 BUNDERS, J. 1988. **Biotechnology and appropriate farming systems.** *Biotechnology revolution and the Third World: challenges and policy options*. Research and Information System for the Non-Aligned and Other Developing Countries, New Delhi, India. p. 102-133; 48 ref.

This paper suggests that biotechnology can make a positive contribution to sustainable development in rural areas of developing countries by assisting small scale and semi-subsistence farmers, and indicates ways in which research orientations can be identified. Earlier agricultural innovations introduced in developing countries are evaluated in order to distinguish between appropriate and inappropriate technological solutions to the problems of specific categories of farmers. Different types of agricultural problems which hinder sustainable rural development are then identified. This is followed by a typology of farming systems characterized by socioeconomic factors. The objectives of appropriate biotechnology research for different farming systems are identified and necessary conditions for them are discussed. The paper concludes with suggestions for appropriate research.

13 BUSCH, L; LACY, WB. 1989. **Biotechnology and the restructuring of the world food order.** *Sociology of agriculture: technology, labour, development and*

social classes in an international perspective/edited by A Bonanno. New Delhi: Concept Publishing, p. 3-26.

The development of biotechnology and the potential consequences that its implementation and diffusion might have in the world food order are discussed. Biotechnology is a potentially revolutionary technology which refers to the development of biological products through the use of intact organisms or natural substances obtained from organisms. Accordingly, through biotechnology it is possible to replace certain aspects of agricultural production with chemically produced substitutes. Furthermore, it is possible to alter the characteristics of animals and plants through genetic engineering to accommodate specific industrial needs. Also, agricultural commodities can be produced in vitro. Despite the obvious positive consequences that biotechnology can generate, the potential problematic repercussions at the spatial and international levels are indicated. It is pointed out that the possible shifting of agricultural production from the field to the laboratory can fundamentally alter the present city-hinterland relationship and replace it with one in which the hinterland becomes increasingly dependent on the city. Moreover, at the international level the possibility of creating substitutes for tropical crops may be devastating for the economies of Third World countries. Finally, the possible centralization of food production may be paralleled by a concentration of power in the hands of food-producing corporations.

14 CHADHA, MS; RAO, PS; HEBLE, MR. 1988. **Impact of plant biotechnology on national development programmes.** *Biovigyanam*, 14: 1, 18-23; 25 ref.

A general discussion is presented which centres on the value of protoplast culture and fusion, clonal propagation and genetic transformation on crop improvement programmes, with particular emphasis on the work done at the Bhabha Atomic Research Centre. Also discussed is the use of cell cultures for production of synthetic compounds and current research in their applications. Process development and mass cultivation is also covered.

15 CHANDEL, KPS; PANDEY, R; CHAUDHURY, R; BALACHANDRAN, SM; SHARMA, N. 1988. **Biotechnology - its role in conservation of plant genetic resources.** *Plant Genetic Resources - Indian Perspective*/edited by RS Paroda et al. p. 499-516.

16 CHATTERJEE, A. 1990. **Economic significance of biotechnology in India.** *Yojana*, 34: 3, 12-15; 5 tab. Technical innovation and the changes which it brings is

the key to the process of economic development. The article focuses on one type of technology which has immense potential for India: biotechnology. About 38 research institutions are involved in biotechnology research in India and the technological gap between India and the developed world could be narrowed down quite considerably by the turn of the century. Potential areas of application including: agriculture; animal husbandry; aquaculture; human health; population control; chemical feedstock; waste purification; and bio-mass cultivation are discussed.

17 COCHRANE, WA. 1987. Biotechnology: industrial processing and distribution of vaccines and hormones. *Agricultural applications of biotechnology: Proceedings of the Nayudamma Memorial Symposium.* (Madras: 1986: Dec 5-17)/edited by AN Rao, HYM Ram. Committee on Science and Technology in Developing Countries, Madras, India. p. 121-138.

18 DEMBO, D; MOREHOUSE, W. 1987. Trends in biotechnology development and transfer. *Technology Trends Series, UNIDO, United Nations Industrial Development Organization, Austria, No. 6: 95 p.*

This report discusses the organisation of research and the development and marketing of products and processes in biotechnology. It contains examples of biotechnology agreements involving the Universities, industry and governments (some of which involve animal or plant genetic engineering), some case studies on research and development (e.g. Genentech. and Calgene in the USA), and some recent marketing and production agreements (e.g. on genetic engineering, diagnostic aids for animal and plant diseases, and the prediction of ovulation in cattle). The implications of biotechnology for developing countries is discussed. An International Centre for Genetic Engineering and Technology is being set up within the United Nations system, with the objective of enhancing the biotechnological capability of developing countries. This will have a centre in Italy and one in India, the former dealing with energy, industrial technology and pollution abatement, and the latter with human health and fertility, animal health and productivity, and agriculture.

19 DEO, SD; MOHSENI, N. 1989. Biotechnology and development of agriculture in Third World countries: the next phase of technology transfer. *Sociology of agriculture: technology, labour, development and social classes in an international perspective*/edited by A Bonanno. New Delhi: Concept Publishing, p. 27-54.

After a detailed analysis of the historical and theoretical aspects of the development of science and technology, the paper explores the historical conditions and patterns which have characterized the transfer of technology to the Third World. Furthermore, it assesses the impact of new technologies on developing countries in terms of dependency and future outcomes. The conclusions indicate the 'nonrevolutionary' character of biotechnology. More specifically, it is argued that the development and implementation of biotechnology does not address the needs of poor small farmers or the vast majority of dwellers in Third World countries. Indeed, the development of biotechnology fosters patterns of agricultural dependency already established by the Green Revolution. Increasing pauperization, concentration of power in the hands of developed countries, and the perpetuation of the existing structure are viewed as the major possible outcomes of the current development of biotechnology.

20 DEO, SD. 1991. Implications of biotechnologies for Third World agriculture: lessons of past and prospects. *Biotechnologies in perspectives*/edited by Albert Sasson and Vivien Costarini. Paris: Unesco, p. 19-25.

21 FARRINGTON, J. 1989. Agricultural biotechnology: prospects for the Third World. Overseas Development Institute, Regent's College, Inner Circle, Regent's Park, London NW1 4NS, UK. 88 p.; 70 ref. The substance of the first 3 chapters was presented at an Overseas Development Institute seminar in 1988 entitled 'Agricultural Biotechnology and the Third World: prospects and policy issues'. Chapter 1 addresses the broad issues in agricultural technology production and trade. The middle chapters consider recent advances in plant and animal biotechnology in developing countries, with the 4th (final) chapter assessing the future implications in these areas. There is a glossary of around 100 biotechnological terms, a list of international agriculture research centres with particular crop or animal production mandates, a description of fermentation products and a brief portrait of agricultural biotechnology in India.

22 GANGULY, AS. 1985. Biotechnology: new frontiers in Indian agriculture. Forum of Free Enterprise, Bombay, India. 28 p.

The potential impact of new developments in biotechnology on Indian agriculture is examined. Specific developments discussed are: hybrid seeds; tissue culture; genetic engineering; photosynthesis improvers; growth

promoters and regulators; bio-insecticides and pheromones; oilseeds, plantations and non-conventional oils; milk production; and fish farming. It is concluded that in a resource-short country like India, biotechnology has a major contribution to make. It is essential to develop a national approach which will unify the efforts of the government and private industry.

23 HOSSAIN, MG. 1995. Biotechnologies in Bangladesh - orphans in prison cells. *International Symposium on Development of Small and Medium Scale Enterprises for Biotechnology Commercialisation in Developing Countries.* (Manila, Philippines: 1995: July 24-28). Bangladesh Agricultural Research Council, Dhaka.

24 HOSSAIN, MG. 1992. Status of small-scale agricultural biotechnology in Bangladesh. *Lab to Land: Biotechnology for Sustainable Agriculture in Asia* edited by J Ferchak and S. Rebeiro. Washington: ATI, 12-28.

25 ISLAM, AS; SERAJ, ZI. 1990. Application of biotechnology in agriculture with special reference to Pakistan. *National Symposium on Plant Breeding in Bangladesh: Proceedings.* Plant Breeding and Genetics Society of Bangladesh, Dhaka. p. 211-218.

26 JAIN, SC. 1990. Biotechnology: opportunities in rural development. *Journal of Rural Development (Hyderabad)*, 9: 4, 659-674; 2 tab.

Advances in the field of biotechnology have potentials for application in rural development in the following areas: in the agriculture sector for the development of organic fertilizers and pest control, crops with greater stress tolerance, and high yielding crops; in animal productivity for improving milk yields, developing vaccines for reducing disease and for sterilization, production of superior animals through embryo transfer technology; in aquaculture to raise fish and prawn production; in the field of human health to eradicate diseases and in family planning; and for the more efficient production of fuel and fodder. The technologies involved are not capital intensive and are manpower and technique oriented. It is an area which will see close cooperation between scientists, technologists, industrialists and the people who will ultimately use and benefit from it.

27 JAYARAMAN, K. 1992. Biotechnology could be the winning formula: agricultural economy of India. *Prophyta*, 46: 2, 42-45.

28 JUNNE, G. 1988. Incidence of biotechnology advances on developing countries. *Biotechnology revolution and the Third World: challenges and policy options.* Research and Information System for the Non-Aligned and Other Developing Countries, New Delhi, India. p. 193-206; 14 ref.

This paper presents an overview of recent developments in biotechnology and their impact on the commodity exports of developing countries. On the basis of available information regarding the pace of substitution in respect of various selected commodities (including sugar, cocoa, vanilla beans, soyabeans and gum arabic), the likely loss of export earnings to the developing countries is estimated. The results emphasize the need for short-term and long-term interest of affected developing countries. An outline of such measures involving action at the national and international levels is presented.

29 KUMAR, N. 1988. Biotechnology revolution and the Third World: an annotated bibliography. Research and Information System for the Non aligned and other Developing Countries, New Delhi, India. 74 p.

The Research and Information System for the Non-Aligned and other Developing Countries in New Delhi, India, has undertaken a research study on the implications of biotechnology for the developing countries. This bibliography lists the literature and documentation which has been gathered from various sources: 650 citations are classified under nine broad headings which deal with developments and policies in biotechnology; the potential and applications of biotechnology; the impact of biotechnology on developing countries and environmental and safety concerns; plant genetic resources; plant breeders' rights; organization of research and development and technology transfer in biotechnology; the biotechnology industry; international cooperation; and regional and country studies.

30 MATHESHWARI, SC; RASHID, A; TYAGI, AK. 1983. Anther/pollen culture for production of haploids and their utility. *Newsletter, International Association for Plant Tissue Culture*, No. 41: 2-9; 79 ref.

This survey covers current techniques, genotype and growth conditions of the donor plant, treatment of flower buds or anthers before and after culture, culture media and growth regulators, and cellular and subcellular development in culture. Physiological aspects are emphasized and information from studies on a range of crop species are included.

31 MIAH, MAA. 1984. **Biotechnology in crop improvement.** *Fourth National Botanical Conference.* (Dhaka: 1984: Dec 1-2).

32 MIAH, MAA; MOSTAFA, MG. 1990. **Breeding lines developed through the application of biotechnology.** *Proceedings of the International Symposium on Molecular and Genetic approaches to plant stress.* (1990: February 14-17). International Centre for Genetic Engineering and Biotechnology, New Delhi.

33 MODI, VV; LLOYD, D. 1989. **Biotechnology in India.** *International Industrial Biotechnology*, 9: 1, 18-19.

The establishment of biotechnology schools at about a dozen centres is mentioned. Proposed industries include manufacture of *Rhizobium* cultures and tissue culture of a variety of economically important plants. The volume of the Indo-US Vaccine Action Programme in stimulating biotechnological development and collaboration in many areas is stressed. Brief details are given of several research centres involved in biotechnology in India.

34 MUKHERJEE, S GUHA; SARIN, N BHALLA; SOPORY, SK. 1983. **Problems of induction of differentiation in haploid cells.** *Phytomorphology*, 33: 1/4, 92-95; 24 ref.

A survey of the subject is presented which deals with problems of regeneration in pollen cultures and also with techniques for manipulating haploid cells with a view to obtaining an improved understanding of these problems (mutation studies, isolation and fusion of protoplasts, incorporation of exogenous DNA and biochemical tests).

35 NARAYANAN, KR. 1989. **Public policy implications of biotechnology for Asian agriculture.** *Current Science*, 58: 10, 534-536.

The relationship between nature and science is considered. The potential benefits of biotechnology to the developing nations are surveyed. Some legal and moral implications of the "biotechnological revolution" are pointed out. It is emphasized that developing countries need to do their own biotechnological research and cooperate with one another. Attention is then briefly focused on research in India.

36 PANDIAN, TJ. 1987. **Biotechnology in aquaculture.** *Agricultural applications of biotechnology: Proceedings of the Nayudamma Memorial Symposium.* (Madras: 1986: Dec 15-17)/edited by AN Rao, HYM Ram. School of Biological Sciences, Madurai Kamaraj

University, Madurai 625 021, India. p. 181-186; 5 ref. This discussion considers methods of producing all-male or sterile batches of tilapias (*Oreochromis*) by hormonal sex reversal, manipulation of ploidy or hybridization.

37 PATIL, MS. 1993. **In vitro studies.** *Advance in Plant Biotechnology and Biochemistry*/edited by M1 Lodha, SL Mehta, S Ramgopal and GP Srivastava. Institute for Pulses and Oilseeds Research, ARS, Gulbarga-585 101. p. 101-107.

38 RIAZUDDIN, S. 1988. **Development of training programmes in biotechnology safety and risk assessment.** *BioEssays*, 9: 4, 131-132.

In an article based on a position paper prepared for the United Nations Environment Programme a brief outline of suggested course content for biotechnological training in developing countries is presented, with particular reference to safety aspects.

39 RIAZUDDIN, S; NASIM, A. 1989. **Future growth in biotechnology in the developing countries.** *Genome*, 31: 2, 1042-1045; 8 ref.

Current initiatives are highlighted with particular reference to work at the Centre for Advanced Molecular Biology. Training of new biotechnologists by developed countries for the developing countries must take account of projected future programmes in the developing countries and the need for onsite practice there. Bodies involved in collaborative ventures mentioned include the Programme in Science and Technology Cooperation (USA), the US National Science Foundation, the International Development Research Centre (Canada), IRRI, CIMMYT and the International Centre for Genetic Engineering and Biotechnology (Italy and India).

40 SARKAR, A; PAUL, J; SAXENA, S; VARMA, A. 1985. **Microbes and cellulose biotechnology.** *Indian Journal of Agricultural Chemistry*, 18: 2, 221-238; 27 ref.

One thermophilic alkalophilic (*Bacillus thermoalkalophilus* sp. nova) and 6 mesophilic (*Micrococcus roseus*, *M. luteus* and *Cellulomonas* spp.) bacteria capable of digesting cellulose in aerobic conditions were isolated from termite (*Odontotermes obesus*) mound soil and termite gut in semi arid areas of northern India. Bacteria were cultured in carboxymethyl cellulose (CMC) media. Optimum concentrations of CMC were 1% for *Bacillus* and 2% for *Cellulomonas*. Optimum pH was 8.0 - 9.0 for *Bacillus* and 6.8 - 7.6 for the other bacteria. Termite gut bacteria were coccoid and those from soil bacilli. *M.*

roseus and *M. luteus* depolymerised cellulose effectively. Several bacterial isolates contained carotenoid pigments.

41 SARMA, BP; BALACHANDRAN, SM; BENTUR, JS; GHOSH, A. 1991. **Biotechnology Programme at Directorate of Rice Research.** *National Group Meeting on rice biotechnology.* (Hyderabad, AP: 1991: September 9-10). Directorate of Rice Research, Hyderabad, AP, India. p. 23-27.

42 SARWAR, M. 1990. **Role of biotechnology in enhancing crop production.** *Progressive Farming*, 10: 5, 44-49.

After pointing out the need to increase food production, the author suggests some applications for biotechnology, then briefly considers rapid clonal propagation, embryo culture, anther culture, in vitro flowering and gene transfer via protoplast fusion, electroporation, *Agrobacterium*, particle guns and inhibition of DNA.

43 SESHADRI, CV. 1983. **The biotechnology situation in India - biotechnology for villages.** *Biotechnology in developing countries: Proceedings of a symposium.* (1982:13-14 Oct). Netherlands: Delft Univ. Press, p. 59-69; 8 ref.

The first part of this paper reviews the biotechnology situation in India as the region in South Asia where an important part of the activity in this field seems to be concentrated. The second part deals with work in rural areas including the utilization of water hyacinth [*Eichhornia crassipes*], the mass cultivation of algae, and biogas plants.

44 SETHURAJ, MR; RAO, GG; ASOKAN, MP. 1989. **Prospects of biotechnology in plantation crops.** *Journal of Plantation Crops*, 16 (Supplement): 9-16; 62 ref.

Techniques showing potential for breeding plantation crops are outlined. They include (1) micropropagation and cell selection/somatic embryogenesis in rubber to develop elite clonal plants with their own roots and to produce drought and cold tolerant forms, respectively, (2) micropropagation for rapid multiplication and improvement of yields in cardamom, (3) rapid multiplication of coconut with emphasis on disease resistance, (4) rapid clonal propagation by meristem culture in cashew, especially for the production of pathogen tolerant material, (5) selection and regeneration of rust [*Hemileia vastatrix*] resistant coffee cell lines, (6) somatic embryogenesis or micropropagation of oil palm to develop higher yielding elite clonal progenies and (7)

micropropagation or techniques exploiting somaclonal variation to obtain tea varieties with enhanced leaf quality.

45 SOSSOU, J; STAGIAIRE, B; SEETHA, K. 1987. **In vitro explanting in the field.** *Plant Genetic Resources Newsletter*, 69: 7-18.

46 SRIVASTAVA, HC; BHARTENDU-VATSYA; MENON, KKG. 1986. **Plantation crops: Opportunities and constraints. 2 Vol.: Proceedings of the symposium on plantation opportunities in India.** New Delhi: Oxford & IBH Publishing, 411 p.

A conference organized by the Hindustan Lever Research Foundation, who also hold the copyright. The first volume contains 49 papers arranged in 2 sessions: Social forestry, energy plantation, industrial plantation (29 papers); and Spices and condiments, aromatic and medicinal plantations (20 papers). Volume II contains 35 papers in a further 3 sessions: Beverage plantations, oilseed plantations (13 papers); New genetic resources - tissue culture (7 papers); and Fruit and other plantations (15 papers). Both volumes contain a list of contributors, recommendations, a general index and an index of scientific names.

47 SWAMINATHAN, MS. 1988. **Biotechnology and sustainable agriculture.** *Biotechnology revolution and the Third World: challenges and policy options.* Research and Information System for the Non-Aligned and Other Developing Countries, New Delhi. p. 33-54

This paper defines the role of biotechnology in the development of sustainable agriculture. The discussion focuses on two major issues: the economic sustainability of high yield technology; and the ecological sustainability of high yield technology. Current optimism concerning what can be accomplished through biotechnology research in terms of practical achievements in agriculture is justified, but further research using conventional techniques is required before the potential of molecular genetics in crop improvement can be fully exploited. Research priorities are outlined.

48 SWAMINATHAN, MS. 1993. **Integrated application of biotechnology in crop improvement: workshop summary.** *Biotechnology in agriculture* edited by CB You, ZI. Chen and Y Ding. Dordrecht, Netherlands: Kluwer Academic Publishers, p. 510-512.

49 THACKER, SP; SINGH, G; SHARMA, RK; KOTHARI, RM. 1991. **Development of biotechnological applications of biotechnology.** *Recent Advances in*

Industrial Applications of Biotechnology. (NATO Advanced Study Institute, Kusadasi, Turkey). p. 375-380.

50 VARADARAJAN, S. 1989. Biotechnology developments. *Current Science*, 58: 10, 531-533.

The range of techniques and applications of biotechnology are briefly surveyed. The author gives a personal view of developments discussed at 2 recent seminars, "Biotechnology and allied sciences" and "Public policy implications of biotechnology for Asian agriculture". These developments include production of high quality vaccines, early detection of disease, a single treatment male contraceptive, biological control of agricultural pests and mosquitoes, the incorporation of resistance genes into plants, tissue culture propagation of plants, and the large scale production of nitrogen fixing bacteria. The author voices the fear that major international food companies may not make the benefits of biotechnology accessible to small farmers. There is a possibility that production of cocoa butter and other high-value items by new biotechnological methods would replace imports from developing to developed countries. Patent and safety regulations are discussed.

Plant genetics

51 ALAM, KAZI BENOZIR. 1994. Plant and microbial molecular genetics. (ACIAR, Crawford, Australia: 1994: Nov. 13-Dec 14).

52 PAL, A. 1993. Gene transfer in higher plants through biolistic delivery. *Proceedings of Indian National Science Academy*, 59: 1, 87-94.

53 RASHID, A. 1988. Cell physiology and genetics of higher plants. Volume I. Boca Raton, Florida: CRC Press, 169 p.

This, the first of a 2 volume series, is based on an M.Sc. botany degree course devised by the author and comprises 4 chapters. Chapters 1 and 2 on cell multiplication and differentiation are devoted to the fundamental aspects of cell physiology which are necessary as a base for the understanding of the application of biotechnology to higher plants. Included in the chapter on cell differentiation is an account of the biosynthetic potential of higher plant cells. Chapter 3, entitled Cell totipotency, is concerned with the regeneration potential of higher plant cells for micropropagation. The final chapter, Induction of the haploid plant/cell, describes the production of haploid plants by anther and pollen culture. References are placed at the end of each chapter and

there are many figures, black-and-white plates and a subject index. This broad and informative book is a synthesis of cell physiology and genetic engineering which will be appealing to plant physiologists, geneticists, cell biologists, plant breeders and biotechnologists.

54 RASHID, A. 1988. Cell physiology and genetics of higher plants. Volume II. Boca Raton, Florida: CRC Press, 189 p.

This, the second of a 2 volume series, comprises 5 chapters. Of these, 4 are devoted to the techniques of cell genetics and their applications (including protoplast isolation and cell regeneration, genetic transformation, protoplast fusion and somaclonal variation). The final chapter deals with cell preservation as a method of storing germplasm. References are placed at the end of each chapter and there are many figures and black and white plates.

55 SUBRAMANIAM, B. 1990. Genetic engineering - a boon or a bane. *Journal of Scientific and Industrial Research*, 49:2, 49-52.

Some of the achievements and possible risks associated with biotechnology are briefly considered. The impact of product substitution 'gene policy' (unethical exploitation of genetic resources), and bovine somatotropin on developing countries is mentioned.

56 TYAGI, AK; KELKAR, NY; KAPOOR, S; MAHESHWARI, SC. 1989. Genes of the photosynthetic apparatus of higher plants - structure, expression and strategies for their engineering. *Photosynthesis: molecular biology and bioenergetics*/edited by GS Singhal, J Barber, RA Dilley, GR Haselkorn, P Mohanty. New Delhi: Narosa Publishing, p. 3-20; 98 ref.

This review is organized into the following sections: (1) structure and organization of genes for proteins of the photosynthetic membranes (photosystem I and II, cytochrome b-f complex, genes for other proteins associated with electron transport and ATP synthase), (2) regulation of expression (regulation of genes of chloroplast DNA and regulation of nuclear genes) and (3) strategies for engineering genes for the study of structure-function relationships and for biotechnology. A list of higher plant genes encoding proteins constituting photosynthetic membranes is included.

Plant breeding

57 DEBNATH, SC. 1990. Cell and tissue culture techniques as supplementary tools in plant breeding. *Proceedings of the First National Symposium on Plant*

Breeding in Bangladesh. Plant Breeding and Genetics Society of Bangladesh, Dhaka. p. 202-210.

Crop improvement is primarily achieved by the production of better varieties using classical breeding procedures. Cell and tissue culture techniques can also play important role in crop improvement. Plant cell culture is applicable in the range of research laboratory to practical breeding. Plant regeneration through tissue can be utilized to recover unique variants which can profitably be used to complement existing breeding programmes. Meristem culture is a very useful method for obtaining pathogen-free materials. Anther and protoplast cultures have opened a new area in crop improvement. Protoplast fusion is the probable means of producing desirable hybrids between closely related and unrelated plants which are not possible by conventional methods. However, cell culture will not replace the classical breeding system, but will help to increase the efficiency of specific steps in breeding procedure. The paper also describes the procedures of various techniques used in plant cell and tissue culture.

58 HOSSAIN, MA. 1990. **New approaches for the improvement of crop plants**. *Proceedings of the First National Symposium on Plant Breeding in Bangladesh*. Plant Breeding and Genetics Society of Bangladesh, Dhaka. p. 188-201.

59 MATHEWS, H; BHATIA, CR. 1983. **Experimental mutagenesis of in-vitro cultured plant cells and protoplasts**. *Mutation Breeding Newsletter*, No. 22: 12-17; 44 ref.

A table, compiled from the literature, is presented giving mutagens and dosages used to obtain a variety of mutant cell lines (including lines resistant to chemical mutagens, amino acids and pathotoxins, temperature-sensitive lines, polyploid lines and lines with altered chlorophyll and pigment compositions) from cells and protoplasts of tobacco, potato, tomato, carrot, soyabean, rape [*Brassica sp.*], sugarcane, maize and rice. Mutation rates are also given.

60 SAREEN, PK; CHOWDHURY, JB; CHOWDHURY, VK. 1992. **Amphidiploids/synthetic crop species**. *Monographs on Theoretical and Applied Genetics*, No. 16: p. 62-81.

Plant tissue culture

61 ANAND, VV. 1985. **A double-embedding technique for sectioning embryoids**. *Current Science*, 54: 18, 947-948; 4 ref.

A cheap 8-stage method to make embryoid manipulation easier is described, involving the embedding of materials first in agar sol and then, when solidified, in paraffin.

62 BHATTACHARYA, P; DEY, S; BHATTACHARYA, BC. 1994. **Use of low-cost gelling agents and support matrices for industrial scale plant tissue culture plant cell**. *Tissue and Organ Culture*, 37: 1, 15-23.

63 HADIUZZAMAN, S. 1994. **Tissue culture research and achievement in the Dept. of Botany, University of Dhaka**. *Workshop on Present Status and Future Direction of Biotechnological Research in Bangladesh*. (BARC, Dhaka: 1994: June 25).

64 SHARMA, DR; CHOWDHURY, JB. 1989. **Screening variability for salt tolerance through tissue cultures**. *National Symposium on Germplasm Resources*/edited by Paroda. NBPGR, New Delhi, India. p. 539-54.

Plant DNA technology

65 MIAH, MAA. 1986. **Application of recombinant DNA technology in agriculture plant improvement**. *International Seminar on Biotechnology and Genetic Engineering*. (Dhaka: 1986: Jan 25-27).

66 PANDA, SK; MUNSHI, A; RAMESH, R. 1992. **Cloning of hepadnaviruses using microquantity serum**. *Nucleic Acids Research*, 20: 16, 4373; 4 ref.

The yield of DNA obtained with the described method is sufficient (50-200 ng approximately) for cloning. 200-300 transformants per test ligation used were obtained of which approximately 50% were recombinants by colony hybridisation. This procedure has been used to clone both human hepatitis B virus and duck hepatitis B virus genome. It needs only 100 μ l of serum.

67 RAHMAN, A; FAZAL, F; GREENSILL, J; AINLEY, K; PARISH, JH; HADI, SM. 1992. **Strand scission in DNA induced by dietary flavonoids: role of Cu(I) and oxygen free radicals and biological consequences of scission**. *Molecular and Cellular Biochemistry*, 111: 1/2, 3-9.

The naturally occurring flavonoid, quercetin, in the presence of Cu(II) and molecular oxygen caused breakage of calf thymus DNA, supercoiled pBR322 plasmid DNA and single stranded M13 phage DNA. In the case of the plasmid, the product(s) were relaxed circles or a

mixture of these and linear molecules depending upon the conditions. For the breakage reaction, Cu(II) could be replaced by Fe(III) but not by other ions tested [Fe(II), Co(II), Ni(II), Mn(II) and Ca(II)]. Structurally related flavonoids, rutin, galangin, apigenin and fisetin were effective or less effective than quercetin in causing DNA breakage. In the case of the quercetin-Cu(II) reaction, Cu(I) was shown to be essential intermediate by using the Cu(I)-sequestering reagent, bathocuproine. By using Job plots we established that, in the absence of DNA, five Cu(II) ions were reduced by one quercetin molecule: in contrast two ions were reduced per quercetin molecule in the DNA breakage reaction. Equally neocuproine inhibited the DNA breakage reaction. The involvement of active oxygen in the reaction was established by the inhibition of DNA breakage by superoxide dismutase, iodide, mannitol, formate and catalase (the inhibition was complete in the last case). The strand scission reaction was shown to account for the biological activity of quercetin as assayed by bacteriophage inactivation. From these data we propose a mechanism for the DNA strand scission reaction of quercetin and related flavonoids.

Plant propagation

68 BHATTACHARYYA, BC; BHATTACHARYA, PS; DAS, N; DEY S. 1990. **Cost-effective media formulated for in vitro mass propagation of economically important plants.** *Genetic Engineering and Biotechnology Monitor*, 29: 12.

69 SHARMA, DR; CHOWDHURY JB. 1982. **Regeneration in long term tissue cultures.** *Plant Biotech. J.* 10: S, 52-58.

Plant growth regulators

70 ARSHAD, M; FRANKENBERGER, WR Jr. 1992. **Microbial biosynthesis of ethylene and its influence on plant growth.** *Advances In Microbial Ecology*, 22: 69-111.

71 PATTABHI, V. 1990. **Plant growth regulators - their structure and interactions.** *Current Science*, 59: 23, 1228-1235; 65 ref.

The chemical and crystallographic structure of auxins, cytokinins, coconut [*Cocos nucifera*] milk factors with kinetin-like activity ([myo]-inositol, diphenylurea and sorbitol), carbamates, abscisic acid and colchicine are discussed, particularly with reference to their binding to receptor molecules and their modes of action.

Plant viruses

72 MANDAHAR, CL. 1989. **Plant DNA viruses.** *Plant viruses. Volume I. Structure and replication*/edited by CL Mandahar. Boca Raton, Florida: CRC Press. p. 235-258; 95 ref.

In this review, the virion DNA and replication of caulimoviruses (including a model of cauliflower mosaic caulimovirus replication) and geminiviruses (with particular reference to maize streak geminivirus) are discussed.

73 SINGH, RP. 1989. **Molecular hybridization with complementary DNA for plant viruses and viroids detection.** *Perspectives in phytopathology*/edited by NP Agnihotri, N Singh, HS Chaube, US Singh, TS Dwivedi. New Delhi: Today and Tomorrow's Printers & Publishers, p. 51-60; 56 ref.

The steps involved in nucleic acid hybridization methods (preparation of the labelled probes, preparation of samples and their application to the solid support, prehybridization and hybridization of the sample and the detection of the hybridized sequence) are outlined. The application of nucleic acid hybridization to the detection of viruses and viroids and the sensitivity of the technique are also considered.

Angiosperm

74 KAPIL, RN; BHATNAGAR, AK. 1983. **Central cell: pre- and post-fertilization parameters.** *Phytomorphology*, 33: 1/4, 157-167; 50 ref.

The structure of the central cell of the embryo sac in angiosperms and the changes brought about in it during and after fertilization are described and illustrated.

75 RANGASWAMY, NS. 1986. **Somatic embryogenesis in angiosperm cell tissue and organ cultures.** *Proceedings of the Indian Academy of Sciences, Plant Sciences*, 96: 4, 247-271.

A survey of the topic is presented which shows that somatic embryogenesis has been satisfactorily demonstrated in only 102 species, with subsequent plantlet formation in 51. The role of growth regulators and genetic factors in somatic embryogenesis is reviewed.

Other aspects

76 CHOPRA, RN; VASHISTHA, BD. 1990. **The effect of auxins and antiauxins on shoot-bud induction and morphology in the moss, *Bryum atrovirens***

Will. ex Brid. Australian Journal of Botany, 38: 2, 177-184; 20 ref.

The protonema of *B. atrovirens* remains bud-free under ordinary cultural conditions on Nitsch's basal medium. Exogenously applied auxins (IAA, 2,4-D, NAA and beta-naphthoxyacetic acid) induced buds on protonemata whereas antiauxins (maleic hydrazide and TIBA) failed to do so. Morphology of the gametophores depended upon the concn of auxin in the medium. In general, normal leafy gametophores resulted at lower concn, and at higher levels of auxins morphology was adversely affected. Simultaneous application of benzyladenine and 2,4-D advanced bud formation as well as increasing bud number, but had no significant effect on the improvement of shoot morphology.

77 HAAPALA, O. 1984. Chromosome structure and DNA sequence organization. *Nucleus*, 27:1/2, 1-6.

In this survey, the occurrence of chromomeric loops and their interloop spacers is related to known data on DNA sequences, using results from a wide range of plant and animal species. It is suggested that these substructures have sequence-specific dynamic functions and have been conserved during evolution for this reason.

78 NILUFER H KARIM; ZAPATA, FJ. 1988. Effect of stress on plant regeneration from anther culture. *Proc. of the 1st Philippines Nat. Symp. on Tissue Culture in Agri. and For.* (UPLB: 1988: May 26-28).

79 PATANKAR, S; JOSHI, CP; RANADE, SA; BHAVE, M; RANJEKAR, PK. 1985. Interphase nuclear structure in plants: role of nuclear DNA content and highly repeated DNA sequences in chromatin condensation. *Proc. of the Indian Academy of Sciences, Plant Sciences*, 94: 4/6, 539-551; 58 ref.

The proportion of condensed chromatin in 23 species (mainly crop plants), determined by HCl-Giemsa banding and planimetry, varied from 14 to 77%. The amounts in picograms of different classes of DNA in each species were estimated; quantity of condensed chromatin was most highly correlated with amount of highly repeated sequences. This suggested that highly repeated sequences could be important in governing species-specific chromatin condensation in plants. The amount of DNA packaged per unit length of chromatin was also a determinant of interphase nuclear structure.

80 ROY, SK; ISLAM, MS; SEN, J. 1993. Clonal propagation of *Elaeocarpus robustus* through in vitro culture. *Inter. Plant Tissue Culture Conference*. (Dhaka Univ., Dept. of Botany: Dec. 19-21).

81 SEENI, S. 1990. Micropropagation of some rare plants at the Tropical Botanic Garden and Research Institute, Trivandrum, India. *Botanic Gardens Micropropagation News*, 1: 2, 16-18; 3 ref.

Methods and media are described which were used for tissue-culturing the orchids *Vanda coerulea* and *Renanthera imschootiana*, the medicinal species *Adhatoda beddomei*, *Commiphora mukul*, *Holostemma ada-kodien*, *Kaempferia galanga* and *Strychnos colubrina*, and the insectivorous species *Nepenthes khasiana*. Regenerated plants have so far been obtained with *Vanda*, *Adhatoda* and *Kaempferia*. Root tip squashes showed that there were no changes in chromosome number in the regenerated orchid plants although the systems used involved adventitious organogenesis. The medicinal plants appeared to have more specific media requirements than the orchids.

FUNGI

Aspergillus

82 BALASUBRAMANIAN, A; BALASUBRAMANYA, RH; GITA, N. 1974. Effect of benlate on the growth and radioactive (¹⁴C) glucose assimilation by *Aspergillus carneus*. *Curr. Sci.* 43:18, 580-581.

83 BHATNAGAR, RK; AHMAD, S; MUKERJI, KG; VENKITASUBRAMANIAN, TA. 1986. Nitrogen metabolism in *Aspergillus parasiticus* NRRL 3240 and *A. flavus* NRRL 3537 in relation to aflatoxin production. *Journal of Applied Bacteriology*, 60: 3, 203-211; 38 ref.

The relationship between nitrogen assimilation, metabolism and aflatoxin formation was investigated using a toxigenic *A. parasiticus* isolate and a non-toxigenic *A. flavus* isolate. Ammonia from the medium was mainly assimilated via NADP-requiring glutamate dehydrogenase. During growth NAD-requiring glutamate dehydrogenase followed an inverse pattern of activity with respect to NADP glutamate dehydrogenase. Alpha-ketoglutarate, the product of NAD glutamate dehydrogenase, stimulated acetate incorporation into aflatoxins. Glutamine synthetase and ornithine transcarbamylase, both utilizing glutamate as substrate, were assayed under different growth conditions. An important regulatory role for glutamine synthetase is suggested. The metabolic route of asparagine utilization was also investigated. Both the known pathways, glutamate oxaloacetate transaminase and glutamate pyruvate transaminase, operated simultaneously.