

AGROCHEMICALS MANAGEMENT: ISSUES AND STRATEGIES

PREAMBLE

The agrochemicals (pesticides, hydrogels, plant growth regulators etc.) have played a pivotal role in the past in increasing agricultural productivity and production, and in protecting and preserving the human and animal food, feed, health and the belongings. Lately, these have become a topic of public debate, owing primarily to their non-judicious and unscientific use. Nevertheless, it is generally agreed that these chemicals are indispensable to meet the food, health and other needs of the burgeoning human and animal population. Thus, a policy on their use needs to be in place.

Realizing the importance of the subject, the National Academy of Agricultural Sciences organized a brainstorming session on 17th April, 2009 wherein 32 participants of the related disciplines, industry, technology transfer facilitators and others deliberated on the various aspects of the problem. The Brainstorming Session was convened by Dr. Balraj S. Parmar, Former Joint Director (Research), Indian Agricultural Research Institute, New Delhi. The deliberations and discussions brought out the following issues and strategies.

A. Pesticides

Plant protection chemicals have and will continue to play a crucial role in meeting the food, feed and fiber needs of the mankind. Pesticide production in India was reportedly 82000 metric tons in 2005-06 with an economic turnover worth Rupees 68 billion in 2006; over 40% being through exports. However, spurious plant protection products worth Rs. 25-30 billion are also in the commerce. It is noted that these chemicals are endowed with inherent toxicity due to which caution has to be exercised right through their discovery till the final use.

Inherent toxicity

In a similar way to the drugs, the pesticide molecules are inherently toxic. However, the dose draws a line between a poison and a non - poison chemical. The inherent toxicity of pesticides can be tamed to advantage by manipulating the dose parameter. The following policy options are suggested:

- Chemicals with selective toxicity (within pest such as useful and harmful insect, pest to pest, mammal and pest, pest and non-target organism etc.) may be developed / introduced. Pro - pesticides are particularly relevant in this context.

- Development / promotion of high potency chemicals / products based on particularly the natural molecules as prototypes to develop the safer synthetics need encouragement. Integration of biorational approaches with the modern tools such as computer -assisted molecular modeling, quantitative structure activity relationship etc. is suggested.
- Bio-pesticide/bio-regulator option needs to be developed and promoted.
- Development or identification of formulants and/ or auxiliaries that reduce the pesticide dose to mitigate its toxicity needs to be encouraged.
- The allelopathic observations in nature need documentation and exploration to arrive at viable practical options.
- An indiscriminate use needs to be discouraged by encouraging a need based application, such as through integrated pest management, based on economic threshold level of the pest.
- The incorrigible problematic products need phasing out.

Improved utility of limited molecules

Discovery of newer molecules has reached a stage of near saturation. Many newer molecules may not be anticipated in future. Those available will have to be employed judiciously to get the best out of them. Similarly, strategies need to be put in place to mitigate the problems of pest resistance, resurgence and outbreaks of secondary pests. The suggested approaches are:

- Development and promotion of pesticide mixtures.
- Development and use of pesticide adjuvants, such as synergists.
- Integrating the use of synthetic and natural pest control chemicals, products and other agents including situation specific use of genetically engineered crops and microbes.
- Evolving appropriate application strategies (ex. product rotation).
- Critical appraisals on continuance or otherwise of generic products of proven utility in the national context.

Protection of useful forms of life

Safety of a chemical to all the useful forms of life is a pre-requisite to its use as a pest

management tool. Humans, other mammals, avian, useful insects, natural enemies of pests, flora and fauna have to be protected at all cost to ensure conservation of the biodiversity; at least the useful ones. The following safety measures are suggested.

- Compliance to the environmental and ecological safety norms needs to be ensured.
- Non - target organisms (humans, wildlife, useful insects, natural enemies of pests, aquatic organisms, flora-fauna, etc) may be identified for each region of chemical and non-chemical inputs in the country to enable strategy for their protection.
- Science backed strategy for protection and promotion of the natural enemies of pests needs to be evolved, comprising use of selectively safe chemical molecules, training on identification and monitoring of the natural enemy, establishing threshold limits on crop / pest, maintaining thresholds through need based extraneous introductions, mass multiplication and easy availability of the agent, etc.
- Monitoring of the toxic residues in plant and plant derivatives, animal based food and feed, and environment may be made mandatory.
- Good agricultural practices (GAP) are to be defined for each crop with respect to use of chemicals, ensuring compliance.
- Establish and specify the maximum residue limit (MRL) and the waiting period for each chemical-crop combination in practice and ensure compliance.
- The safe limits for every non chemical- crop combination in practice be established and compliance ensured.
- Monitoring programmes to ascertain the environmental load of finer (micro-, nano- and pico-meter) sized toxic particles need initiation and their implication in human and animal health established.
- The fate and long- term impact of auxiliaries (adjuvant, formulants etc.) on environment quality, mammals, avian, various other non- targeted, particularly the useful organisms needs to be researched and a data base created for future reference and use.
- The occupational, consumer and user risks associated with a chemical may be highlighted separately for men, women and children. Cumulative risk needs to be evolved for all the products in use from a class and not just individual products.
- Decontamination and detoxification strategies for different chemicals in different matrices and environment components need development and implementation.

- Emetic addends for pesticides to induce vomits in accidental or intentional intakes need to be evolved and used.

Bio-pesticides

Bio-pesticides, either alone or along with the chemical products are projected as a promising input for pest control. The policy options have to not only take into account their utility but also ensure steps for overcoming the limitations to sharpen their teeth for sustained effectiveness.

- The concepts of bioregulatory and organism based pest control need development, sharpening and promotion with a particular reference to the organic agriculture.
- Focused efforts to develop economic, efficient and safer products are needed, exploring novel approaches to formulate microbial agents in view of their distinct requirements.
- Pest target sites more amenable to biomolecules need identification for improving the pest management efficiency.
- Standard and stable products with improved knockdown, kill and shelf and field lives need development and promotion.
- Development and promotion of viable combination products based on synthetic and natural materials deserve encouragement.
- Efficient and economically viable technologies for the multiplication of microbes need development and promotion.
- Special attention may be accorded to chemicals of microbial and aquatic fauna origin in various pest management applications.
- A critical appraisal of the slow adoption of bio-pesticides by consumers may be undertaken and the constraints addressed.

Pesticide Formulations

Formulation science has progressed tremendously during the past over three decades or so. However, the art of formulation is still a closely guarded money-minting secret of the industry. In view of the limited scope of developing newer molecules and products, the subject of formulation has attained a pride of place in pesticide science. The following activities will help to acquire a leadership role in this field.

- Formulation research, teaching and development need strengthening in the National Agricultural Research System.
- Novel approaches to formulate pesticides, particularly the bio-pesticides and microbial agents may be given a special attention keeping in view their distinct requirements.
- Development and use of environment-friendly products and technologies needs specific encouragement.
- Special attention needs to be accorded for the improvement of shelf and field lives of the biomolecules and biopesticidal organisms, particularly through protection of the active ingredient such as by encapsulation or otherwise, for sustained release or mitigated physico-chemical degradation, or inhibition of the metabolic activity of the organisms.
- A high priority needs to be accorded to research on development of indigenous and safer auxiliaries and formulants.
- National policy on the development and use of multi-pesticide formulation as well as multi-formulation pesticide mixtures is suggested, defining particularly the number of ingredients to be allowed.
- The specifications and methods of analysis, particularly for multi-phase products, need to be prescribed.
- All approvals for the use of pesticide mixtures must specify antidotes and the method of their use.
- Field performance data under different agro-climatic conditions may be made obligatory for the mixed formulations.
- Application technology needs to be developed to cope up with the requirements of modern high potency products, extremely low application doses, safety needs etc.
- Compliance to the application schedules, guidelines and precautions may be enforced in letter and spirit.
- A network of qualified and certified dealers, applicators etc. may be created to promote quality products and to minimize performance related complaints at the field level, and made available for a reference and use by all concerned.
- Research backed practices for the joint application of chemical and non chemical inputs may be explored to improve economy, safety and efficiency of pest management.

Handling, storage, transportation

The importance of proper care in the handling of pesticides hardly requires an emphasis. Realizing this, the guidelines to handle them at different stages have been prescribed and are available. Proper enforcement of these guidelines is essential.

- Compliance to the prescribed schedules and guidelines for handling, storage, packaging, transportation, etc. of the technicals and the formulations may be enforced from the time of manufacture till impact assessment, with effective deterrents against casual approach.
- Innovative and effective handling equipments and devices (convenient protective clothing, shoes, eye glasses, masks, weight lifting pads etc.) that are readily adoptable under the harsh tropical weather conditions of the country may be developed.

General regulatory issues

The different enactments relating to pesticides are enforced through different ministries such as agriculture, health, chemicals and others. Quite often, a coordinated effort is lacking, leading to debate on the continuance or otherwise of the current system. Streamlining of the system is warranted.

- The contemporary and not individual interest of the consumer, producer and government in the national economy and trade needs promotion.
- The consolidation and rationalization of the acts and the regulatory agencies is required. Single nodal agency like the United States-Environment Protection Agency addressing to all aspects of plant protection chemicals including harmonization of laws, is suggested.
- The draft of the newly proposed Pesticides Act requires a critical public and scientific scrutiny before its enactment by the Government. The interests of the first registrant of a product, who incurs heavy costs to comply with the registration requirements, need due protection through stringer guidelines for repeat registration. Several other issues such as an independent national system to undertake product appraisals to recommend uses, safety checklists in conformity with FAO guidelines, re-registration guidelines for good generic products, heading of various technical committees by agrochemical experts and not general agricultural experts etc. need a logical and unbiased resolution. Input by organizations such as Society of Pesticide Science, India may be useful in resolving the issues.
- Implementation and not merely the enactments need to be ensured.

Quality issues

A quality product to the maximum satisfaction of the consumers has to be the watchword of any production system. Quality must, therefore, be ensured at all costs. It is suggested that :

- Quality control and quality assurance set up and its *modus operandi* may be defined.
- Good manufacturing / handling practices and quality may be made a watchword in every aspect of product development and domestic and international trade.
- The quality parameters and their limits need to be prescribed carefully keeping the prevalent national conditions and capabilities in view. These should not merely be a copy of the international standards.
- An independent and unbiased set up may evaluate and authenticate the quality parameters and the test methods before their adoption as national standards.
- A network of test and certification systems with established credentials of men and machines (accreditation, international recognition, etc.) may be created.
- Quality may be enforced through accountability of the erring party in a time bound manner.
- Reliability of the quality assurance statement on the product package may be ensured.
- Strong and unified statutory provisions for product quality and its assurance need to be established and implemented.
- Illicit trade in the products of doubtful origin must be curbed.
- Claims through tailored analysis reports, false label information, duplicate labels, etc. may be treated as serious offences.
- Law must curb fraud including the deceit and adulteration.
- Penalties may be streamlined to serve as effective deterrents.
- Impediments to the national resolve to set the matters straight may be dealt with strictly.

Environmental interactions

Introduction of the man made chemicals into the environment is only a part of the

problem. Besides, there is continuous introduction of a number of natural emissions from various flora and fauna. The natural chemicals interact not only amongst themselves but also with those introduced from the extraneous sources. These interactions need an investigation for a proper understanding.

- Information on the interaction amongst chemicals introduced naturally in the environment through various plant and animal emissions and their impact on plant or mammalian systems (ex. allergenic effects) needs to be generated.
- Joint action / toxicity of natural chemicals (constituents of plant or animal products) with those introduced extraneously into the environment and their impact on plant or animal systems (ex. synergistic toxic effects of special concern) may be investigated and areas of concern identified.

Consumer awareness, disposal /decontamination

Consumer awareness is vital for the health of a progressive society. Both the positive as well as the negative effects of chemicals must be known. In particular, awareness on the shelf and field lives of chemicals, their quality, use spectrum, disposal, decontamination, handling of accidental poisoning cases, various antidotes etc. is paramount.

Consumer awareness and care

- Consumer awareness on the different aspects of chemicals such as product quality, use, activity spectrum etc. through various government, non-government and private agencies needs to be created.
- An effective consumer care system must be put in place.
- Deterrents for preventing customer cheating may be enforced.
- Devise mechanisms and deterrents for preventing the foul play by any of the industry, consumer or the government.
- Symbolic labels may be designed and prescribed for illiterate masses. In printed matter, use of vernacular language and readability of the font size ought to be ensured.
- Training on handling of the chemical accidents may be imparted at basic level along with an easy and assured access to first aid and antidotes.

Disposal / decontamination

- Parameters (concentration, physico-chemical character, etc.) to govern disposal/

decontamination strategy on the chemical wastes (chemical, photochemical, biological, etc.) may be defined and the specifications prescribed.

- Parameters for choice of the disposal structures (*kacha*, concrete lined, polyethylene lined, etc.) may be prescribed to regulate environmental introductions.
- Guidelines for the safety of the below ground systems need to be established and prescribed.
- Destruction and removal efficiency (DRE) of incineration plants should guide choice for disposal of different chemicals.
- Formation of the toxic dioxins during incineration must be monitored.
- Research base for developing efficient disposal, effluent treatment and decontamination technologies needs to be strengthened.
- Guidelines for the disposal, recycling and reuse of containers / container materials need to be developed and implemented.
- Development and popularization of decontamination strategies applicable for different products in diverse situations may be taken up on priority.

B. Agricultural Chemicals other than Pesticides

Nitrification inhibitors

In view of the low N use efficiency of nitrogenous fertilizers the world over, particularly the tropical regimes, the use of nitrification inhibitors offers a viable option to check their wastage coupled with the environment protection. These deserve a very serious consideration for their promotion and use in Indian agriculture.

- Situation specific use of nitrification inhibitors with nitrogenous fertilizers may be made mandatory after ensuring toxicological safety, environmental compatibility and economics of their use.
- Indigenous products (both botanical ex. karanjin from *Pongamia glabra* and synthetic ex. furfural derivatives) and technologies need preferential promotion.
- Region and crop specific use packages are required to be formulated and promoted.

Seed coats

Seed coats are already being promoted by the multinationals as a monopoly item to provide quality seeds. There is a need to develop these materials indigenously.

- Coats for enhancing seed quality and crop establishment in different environments deserve promotion.
- Their role in mitigating the effect of harsh environment needs to be specifically highlighted for consumer attraction.
- Development of seed coats including those incorporating bio-pesticides is suggested, the latter particularly for organic agriculture.
- Seed coats as situation specific aids to synchronize germination / flowering of male and female parental lines to promote effective fertilization in problematic crops needs exploration in crop breeding / seed production programmes.
- Methods and standards to assess the quality of seed coats may be developed.
- The multifarious utility of incorporating nutrients (particularly micronutrients, lime, sulphur, and plant growth promoters, etc.), colorants and other plant cultivation or growth aids in coats needs exploitation.

Hydrogels

The role of hydrogels in enhancing crop quality and productivity along with increased input use efficiency and improved soil physical environment has brought them to the fore for use in future agriculture. These deserve a serious attention.

- The use as a tool to conserve water, and improve soil physical environment, water and agrochemical use efficiency and crop quality and productivity deserves a serious attention and a policy consideration for a large scale promotion.
- Educate consumers on the multiple benefits from their use.
- Development of innovative methods for production of the xerogels needs to be taken up on priority, addressing particularly to minimize water consumption and an energy efficient water removal during production.
- A uniform standard is required to affix swelling during product development to enable comparison amongst different products. Specific report on saline absorbency under load (AUL) may be prescribed.
- Establish limits and prescribe methodology for monitoring of the unreacted reactants (residual monomer, cross linker etc.) in the industrial effluent.
- Focus researches on natural polymer materials that yield final product of high gel content and minimum sol fraction and residual reactants.

Plant growth regulators

Plant growth regulators are finding increased application for improved plant development and crop yields. There is need for:

- Development of indigenous products and technologies.
- Information and database on products, their utility, and use and safety aspects may be generated.
- Explore sustained release formulations for use.

Chemical hybridizing agents

Heterosis breeding being critical for increasing crop productivity, deployment of chemical hybridizing agents would enlarge the pool of parental lines for developing F1 hybrids.

- Use deserves promotion and evaluation for any possible undesirable effect.

Value adders

Several chemicals are added to the agricultural produce to improve look, shelf life, freshness and other customer attracting parameters. The real worth of several such materials deserves a critical appraisal in the national context. It is high time to put in place a national policy on such materials.

- Chemical and nutritional profiles of naturally and artificially ripened agricultural commodities and produce need to be generated.
- Safety standards may be laid for the residual agents left in the artificially ripened produce.
- Establish safety of treatments (waxes, chemical dips etc.) given to improve the look and shelf life of the produce for better marketing.

C. Technology, Trade, IPR etc.

Technology development and promotion

- Development and use of indigenous technologies and products may be encouraged.
- Knowledge-based linkages amongst research organizations, industry, regulatory agencies and other stakeholders may be established and promoted.
- Utilization efficiency of national infrastructure in generating newer products and technologies needs improvement.

- Develop methods and technologies that mitigate the unwanted natural emissions from the living or dead plants, animals and other organisms.
- Both the bench and pilot scale technology packages need due recognition for technology transfer.
- Domains of small-scale entrepreneurs need to be clearly defined and protected.
- Underline that input as research is only about 5 % of the technology package. Innovation (75%) and development (20%) constitute the rest and fall in industry's domain.
- Create awareness that no single institution can possibly provide the total information, often sought in a technology package.
- A fixed percent of industry's turnover must be ploughed back into research and technology development endeavors. Similarly, government must increase investment in research and technology development with due accountability.

Intellectual property right

- Make the national agricultural research system intellectual property right (IPR) literate with necessary infrastructure.
- Effective and efficient protection and management of the IP needs to be ensured.

Trade and commerce

- Free and fair research and development backed product promotion and trade needs to be encouraged, if required through fiscal benefits and other support.
- Export of indigenous products and technologies needs promotion, if necessary through fiscal and policy support.

Documentation and database

- Information on all the aspects of agrochemicals needs documentation and a database created.
- The information may be made accessible to one and all.
- A mechanism of passing on the researchable issues to the national research system needs to be devised.

D. Human resource development and utilization and creation of infrastructure

Human resource development and utilization

- Biodiversity management in the context of agrochemical use needs to be included in the curricula of schools and colleges.
- Manpower with chemistry background available in the National Agricultural Research System (NARS) must address to the chemical issues related to agriculture in general and agrochemicals in particular.
- A strategic national plan for a fruitful utilization of chemists available in NARS needs to be developed.
- The Krishi Vigyan Kendras (KVKs) be strengthened to serve as knowledge based self sustaining agri-clinics to facilitate the diagnosis and finding solution to the constraints related to agricultural production (e.g. soil and crop health, pest, input and produce quality, marketing, post harvest processing, weather forecasts, product recommendation and safety, antidotes, etc.) and render allied services.
- Introduction and promotion of the concept of agricultural graduates as responsible licensed distributors / applicators /consultants of (on) agrochemicals and other agro-inputs are suggested.

Creation of infrastructure

- Establishment of a national centre to cater to all the aspects of education, training, research, development, scale up, commercialization, etc. of agrochemicals including organisms and bioproducts, with a special attention to the problematic areas (control of major pests, quality of imported and exported commodities, etc.) is suggested. Agrochemicals disciplines may be created in all the national and state agricultural universities and research institutes.
- A network of centrally controlled and accredited laboratories may be established to monitor and periodically update the xenobiotic load of the environment related and other natural resources, agricultural and industrial produce and the other commodities.

Others

- Safe food may be integrated with the recognized safety standards, minimum or no risk products and judicious agrochemical management rather than with organic or any other less productive form of agriculture.

- Establishment of multidisciplinary groups at the inter-ministerial level comprising scientists, science managers, and other specialists to periodically review the agrochemical related issues is suggested.
- The urban waste management may be linked to supplementing agrochemical use in agriculture.

E. Recommendations

Policy Issues

1. A national centre on agrochemicals, including organisms and bioproducts, to cater to all aspects of education, training, research, development, scale up, commercialization, etc. needs to be established.
2. A single nodal agency, like the United States- Environment Protection Agency, to address to the multifarious aspects related to agrochemical use in totality needs to be created.
3. A network of centrally controlled and duly accredited laboratories to regularly monitor and update the xenobiotics load of the environment and other natural resources, agricultural and industrial produce and other commodities needs to be established.
4. Investment in agrochemicals research, education and technology generation needs to be increased with due accountability.
5. Only agricultural graduates should be licensed as responsible distributors/applicators/consultants of (on) agrochemicals and other agro inputs.
6. Safe food should be integrated with the recognized safety standards, minimum or no risk products and judicious agrochemical management.

Research & Education

1. Agrochemicals discipline needs to be created in all the national and state agricultural universities and research institutes.
2. Biodiversity management in the context of agrochemical use should be included in the curricula of schools and colleges.
3. Krishi Vigyan Kendras need to be strengthened as the knowledge based self sustaining agri-clinics for the diagnosis and solution of the constraints related to agricultural production and the human safety.

4. Multi-disciplinary groups at the inter-ministerial level comprising scientists, science managers, and other specialists to overview periodically the agrochemicals scenario need to be established.
5. Information on all the aspects of agrochemicals needs to be documented and a database needs to be created. This information should be accessible to one and all. A mechanism should be devised for taking the researchable issues to the national agricultural research system.

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- CONVENER** : **Dr Balraj S. Parmar**, Former Joint Director (Research), Indian Agricultural Research Institute, New Delhi
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LIST OF PARTICIPANTS

1. Mr R.G. Agarwal, Chairman, Crop Care Federation of India, New Delhi
2. Dr Anupama, Senior Scientist, Div. of Agricultural Chemicals, IARI, New Delhi
3. Dr P.K. Chhonkar, Former Professor & Head, Div. of Soil Science & Agricultural Chemistry, IARI, New Delhi
4. Dr Ashim Chowdhury, Acharya P.C. Ray Professor, Institute of Agricultural Sciences, University of Calcutta, Kolkata
5. Dr B.V. David, President, Sun Agro Biotech Research Centre, Chennai
6. Dr C. Devakumar, ADG (Edn), ICAR, New Delhi
7. Dr A.K. Dikshit, Head, Div. of Agricultural Chemicals, IARI, New Delhi
8. Dr (Ms) Prem Dureja, Former Head, Div. of Agricultural Chemicals, IARI, New Delhi
9. Dr V.T. Gajbhiya, Professor, Div. of Agricultural Chemicals, IARI, New Delhi
10. Dr Somenath Ghosh, CMD, National Research Development Corporation, New Delhi
11. Dr Madhuban Gopal, ICAR National Fellow, Div. of Agricultural Chemicals, New Delhi
12. Mr Dhruv Gupta, Director, Ozone Biotech, Faridabad
13. Dr K.C. Gupta, Director, Anand College of Pharmacy, Agra
14. Dr R.L. Gupta, Principal Scientist, Div. of Agricultural Chemicals, New Delhi.
15. Dr S.K. Handa, Former Project Coordinator, AICRP on Pesticides Residues, New Delhi
16. Mr B.K. Jain, Director, Earth Intl. Pvt. Ltd., New Delhi
17. Dr Jintendra Kumar, Senior Scientist, Div. of Agricultural Chemicals, IARI, New Delhi
18. Dr Prem Kishore, Former Professor of Entomology, IARI, New Delhi
19. Dr Irani Mukherjee, Principal Scientist, Div. of Agricultural Chemicals, IARI, New Delhi
20. Dr Anil K. Pant, Professor & Head, Department of Chemistry, G.B. Pant University of Agri. & Tech., Pantnagar
21. Dr Balraj.S. Parmar, Former Jt. Director (Research), IARI, New Delhi
22. Dr Rajender Parsad, Advisor (R&D), Dhanuka Agritech Ltd., New Delhi
23. Dr N.S. Pasricha, Former Director, Potash Research Institute of India, Gurgaon
24. Mr A. Pradhan, Sr. Manager & Head, National Research Development Corporation, New Delhi
25. Dr Rajendra Prasad, Former ICAR National Professor, New Delhi
26. Dr N.K. Roy, Former Head, Div. of Agricultural Chemicals, IARI, New Delhi
27. Dr M.S. Sachdev, Principal Scientist, Nuclear Research Laboratory, IARI, New Delhi
28. Dr Shashi Bala Singh, Principal Scientist, Div. of Agricultural Chemicals, IARI, New Delhi
29. Mr Nitin Singhal, Executive Director, Ozone Biotech, Faridabad
30. Mr Salil Singhal, CMD, PI Industries Ltd., Gurgaon
31. Dr A.K. Srivastava, Director and Vice-Chancellor, National Dairy Research Institute, Karnal & Secretary, NAAS
32. Dr Suresh Walia, Principal Scientist, Div. of Agricultural Chemicals, IARI, New Delhi

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NASC, Dev Prakash Shastry Marg, New Delhi - 110 012

Tel : (011) 25846051-52; Fax: (011) 25846054

Email : naas@vsnl.com; Web site: <http://www.naasindia.org>

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(Footnotes)

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