

APN-20008

“Operational support for First South Asian Regional Experiment using 5 country OTC and Mid-FACE network to characterize and evaluate physiological response of rice varieties to CO₂ enrichment for use in crop production, modeling, policy making and management technology assessment.”

April 2000- March 2001

SUMMARY OF THE FINAL ACTIVITY REPORT

Grant approved: US \$ 74,750 **Transferred:** To NPL, India: US \$ 37,450
To other countries US \$ 25,000

Participating Countries: India, Bangladesh, Nepal, Pakistan and Sri Lanka

Objectives:

1. Operationalize a South Asian Regional Network for CO₂ Enriched Rice Research, to provide regional inputs to the International Rice Research Network established under GCTE, through conduct of first regional experiment during July-December 2000.
2. Identification of some rice varieties from each participating country responsive to CO₂.
3. Firming up of protocol for later use of this regional rice research network for characterization and evaluation of physiological response data of rice varieties from different locations in the five participating countries for use in various crop modeling exercises and policy decisions for modifying rice crop production strategies and management technologies.

Activities conducted:

- Expert help from IARI and NPL provided to stabilise the newly created OTC sites in Gazipur near Dhaka in Bangladesh, Rampur and also Kathmandu in Nepal, Battalagoda in Sri Lanka and Islamabad in Pakistan. One Mid-FACE ring operationalized. With this the intended South Asian Network gets realized.
- Several rice varieties grown under Open Top Chambers (OTCs) in the region.
- Additional Open Top Chamber Kits fabricated at New Delhi (NPL) and supplied to 5 more sites in India representing different ecosystem in order to increase the scope of researches possible under SA-CERN
- CO₂ research scientists from the participating countries invited to Delhi to participate in the Workshop during March 16-18, 2001, under this APN Project, to inter-compare results so far, compile the data and draft the regional scientific report to be published in a few months. (Due to unavoidable reasons scientists from Pakistan could not reach Delhi for this workshop. Their visit will take place at a slightly later point of time).
- Evaluate first experimental data from OTCs for their utility in the existing rice model used at IARI.
- Work out a sufficiently detailed protocol for the regionally coordinated experiments on rice in the coming crop seasons.

- To reassemble and conduct operational trials of the Mid-FACE ring along with its CO₂ dissemination and control system from its permanent site allocated by IARI for regular use in the forthcoming crop season and later.
- Future plans to continue regionally coordinated CO₂ experiments discussed and recommendations on this adopted.

Output:

- Regional CO₂ Enrichment Rice Research Network involving a dozen of OTCs in all the countries and Mid-FACE at New Delhi operationalized. This infrastructure along with the scientific community using them will henceforth be referred to as the 'South Asian CO₂ Research and Application Network (SA-CRAN)'
- Mid-FACE ring along with its CO₂ dissemination and control system established in the allotted site by IARI and readied for use in the forthcoming crop season.
- A critical mass of trained scientific manpower created in the region that will sustain CO₂ enrichment activities for many years, subject of course to availability of resources to meet the cost of CO₂ gas in sufficient quantity.
- Scientific results from CO₂ enrichment rice experiments conducted in 2000-01 in the five participating countries with APN support.
- Preliminary evaluation of experimental data already obtained from OTCs carried out to assess their utility in the existing rice model used at IARI made. Keeping this and the requirements of the rice model and the policy planners, a sufficiently detailed protocol worked out for the regionally coordinated experiments on rice in the coming crop seasons.
- Through personal discussions with the concerned officials governmental/funding agencies in various counties sensitised to complement the support provided by APN. Results are very positive.
- Recommendations adopted on continuance of the APN initiated regional activity during next few years in a cooperative manner.
- **Other Related Information enclosed:**
 - Recommendations adopted by the PIs of the four participating countries on continuance of CO₂ enrichment research activities.
 - Programme of the International Workshop held in February 2000 at Dhaka.
 - List of Participants for the above.

**PROGRESS REPORT FOR APN-2008
FOR THE PERIOD APRIL 2000-MARCH 2001**

1. Project Title and APN Reference Number:

“Operational support for First South Asian Regional Experiment using 5 country OTC and Mid-FACE network to characterize and evaluate physiological response of rice varieties to CO₂ enrichment for use in crop production, modeling, policy making and management technology assessment.”

APN Funded Project No.: APN - 2008

2. APN Funding Approved:

US \$74,750 during April 2000 - March 2001

3. List of participating countries:

India, Bangladesh, Sri Lanka, Nepal and Pakistan

4. Introduction/Background:

It is predicted that by middle of the 21st century the level of CO₂ will double with respect to the current levels of concentration in the atmosphere. Different crops are expected to respond differently under these conditions. Rice is the staple diet of the people of the South Asian region and its productivity has to be maintained even under enhanced levels of CO₂ concentration to meet the growing demand. The OTC (Open Top Chamber) technology, a relatively cheaper technology in terms of operational cost, can thus be used in the South Asian countries for a common rice CO₂ enrichment experiment with a view to screen rice varieties which respond significantly to elevated CO₂ in different agro-climatic regions. This experimental effort in coordinated manner across the region can generate data base to characterize the responses of these varieties in term of physiological analysis which will be usable in modifying crop management, nutrient management and water management technology to suit future elevated CO₂ conditions and to enhance crop yield. Dr. D C Uprety and his group in IARI, New Delhi and few other groups elsewhere had carried out preliminary works on the effect of elevated CO₂ on the physiology and yield of rice, wheat, and other crops using Open Top Technology (OTC).

SASCOM had seen the potential of a large regional programme on this topic. They promoted this initially through arrangement of a few START Visiting Fellowships. ICAR, the parent organisation of IARI, continued support for OTC research and CSIR, the parent organisation of NPL, provided seed money to develop one ring of the South Asian Mid-FACE Facility. Dr. Franco Miglietta, Italy helped considerably in realizing this. During April 1999-March 2000 a South Asian Project on ‘Elevated CO₂ and Rice Research’ was established under APN funding to create a South Asian Network of CO₂ Researchers. Under the project Dr. Uprety of IARI and Dr S C Garg of NPL made contacts with the scientists of the South Asian countries to organize a network of institutions in Bangladesh, India, Nepal, Pakistan, and Sri Lanka. In September 1999, a Familiarization Course on ‘CO₂ Enrichment Research and Technology’ was organized in IARI where scientists from the above participating countries joined. A Science Research - Policy Interaction Workshop was also held in Dhaka in February 2000, where it was

decided to run OTC experiments at the sites tabulated below. Prof. Bruce Kimball, USA Prof. Miglietta, Italy and Dr. Kobayashi, Japan in this workshop as international advisors to this regional effort.

NPL fabricated and dispatched one OTC prototype for each location by March 2000 based on the discussion held in Dhaka workshop. Dr Uprety developed and dispatched the experimental protocol to all PI's. One or more OTC's similar to the prototype were fabricated and installed at each location using their own resources. Under the project APN also provided funds for test trials of Mid-FACE at IARI that was developed by NPL in collaboration with CNRS, Italy.

Noting the success of the first year project funded by them, APN approved the funding for the present second phase, April 2000-March 2001, to cover essentially operational expenses for running the regional experiment, visit of the Delhi group to various OTC sites during the crop growing season and provide necessary technical guidance, hosting a workshop to assimilate its outcome and to publish the final report on scientific outcome.

5. Outline of activities conducted:

Activity A: Conduct of regional experiment using existing OTCs:

- The following progress in research work was made at the above listed OTC sites:

BSMRAU, Bangladesh (Gazipur)	<ul style="list-style-type: none"> • fabricated two more OTC's using internal resources; Total 3 • carried out one season experiment with rice (June-Nov) • has set up another experiment with mungbean (on-going)
IAAS, Nepal (Rampur)	<ul style="list-style-type: none"> • fabricated two more OTC's with internal resources; Total 3 • carried out one expt. with rice (July-Nov) • second expt. with wheat (on-going) • had difficulties in setting the expt. • ready for next season's expt.
NARC, Nepal (Kathmandu)	<ul style="list-style-type: none"> • fabricated 2 OTCs with internal resources; Total 3.
CSI, Pakistan	<ul style="list-style-type: none"> • fabricated two more OTC's with internal resources; Total 3 • carried out one expt with rice (July-Nov)
RRI, Sri Lanka	<ul style="list-style-type: none"> • installed OTC's • established the expt. with rice in Dec 2000 (on-going)

Activity B: Expert visits from India to various participating laboratories during crop growing seasons:

Visit of Dr. D. C. Uprety, Dr. Nina Dwivedi and Mr. Rajat to Bangladesh and Sri Lanka

Visit of Dr. Uprety to Sri Lanka

Pending visit of Mr. S. C. Garg to the three countries.

Activity C: Workshop of CO₂ scientists from participating countries at IARI during March 16-18, 2001:

Thirteen participants from outside India and a larger number from IARI & NPL and one scientist each from five other institutions in India interested in CO₂ research took part. List of participants and the programme of the workshop are given in the Annexures to this report. Details of experiments carried out, difficulties experienced in establishing new OTC sites, new scientific data obtained from OTC experiments in the crop seasons during the year were discussed and draft scientific report compiled. Progress on Mid-FACE reported. OTC was evaluated to prepare detailed experimental protocol. Plan for follow up decided. Recommendations and Action Plan described below. Following are the important outcome:

1. Detailed scientific report to be published slightly later. Highlights from experiments on various rice species could be summarised as follows:

- Elevated [CO₂] appreciably increased the leaf photosynthesis rate, number of leaves and tillers, total dry matter, and enhanced nutrient uptake at all the growth stages.
- Elevated [CO₂] increased grain yield of rice. Increased grain yield resulted from greater number of panicles per hill, larger number of spikelets per panicle, and improved grain size.

2. Considerable amount of information on the crop response to elevated CO₂ has been generated. The information might be of immense help in characterizing genotypes and modeling plant type suitable for adaptation under elevated CO₂ concentrations. However, one season's data will not be sufficient to draw sound and meaningful conclusions, for agricultural research is subjected to considerable variation due to many interacting factors. The experiments at each new OTC site needs to be repeated for at least three more seasons.

3. In order to make the experimental data amenable to statistical analysis, experimental 'treatments' need to be replicated and there should, ideally be at least 8 OTC's per location. It is recognised of course that this will raise the experimental cost by three to four times. Resources will have to be raised for this. Resources will also be needed to establish OTC sites to cover other important ecosystems in each country. Each country should have its own sub-network of OTC sites.

4. External funding will be necessary for continuation of the activities. In case the external funding is not immediately available, it is planned to repeat the experiment with currently established OTCs for at least one more season with our internal resources.

5. It is unanimously agreed that the networking of the 'Elevated CO₂ and Rice Research' has been instrumental in creating awareness among the scientists, administrations, policy planners and development workers in the SASCOM countries. To facilitate conduct research aimed at characterizing and modeling growth response of crop varieties for global climate change, it would be of benefit to keep the Network active and alive. In each participating country, therefore events relating to Global Climate Change and Agricultural Production are planned, apart from conducting experiments on rice, wheat, mungbean and other crops.

6. Recommendations adopted and follow up plan are given later in this report.

6. Outcomes/Products (e.g., scientific publications, fellowships, people trained, workshops, etc.):

6.1 A comprehensive report detailing scientific and technical achievements from out of this APN funded project will be prepared after the Dhaka Workshop.

6.2 A larger than a critical mass of trained scientists in five countries that can sustain this new field of activity in the region for many years to come.

6.3 The most important 'product' that will result due to this two year APN funding is realisation of an operational South Asian CO₂ Research and Application Network. This network called, SA-CRAN, comprises all OTC sites in the region and scientists associated in using them or their results, such as modellers in the five countries.

7. Future directions/follow-up work:

Recommendations adopted by the PIs present at the Delhi 2001 Workshop are placed in Annexure. The following action plan beyond the APN funding period was decided and will be pursued:

- OTC experiments at all the sites will be conducted in the next cropping season using internal resources by each country.
- Participating institution to jointly submit proposal to START in response to their recent announcement on GEF linked activity. Dr. Uprety would arrange this in consultation with Shri S. C. Garg, Dr. M. K. Tiwari and Dr. A. P. Mitra and, of course, with participating PIs in other countries.
- Mr. S. C. Garg will visit participating institutions to provide engineering expertise to rectify existing lacunae in the newly crated OTC before rice crop is planted in them, to discuss new OTC sites to cover additional ecosystems in the network and negotiations with local funding agencies for continuance of support.

- Some OTC kits will be distributed to additional sites in India covering other ecosystems in the regional experiments. The already available spare OTC kit will be supplied to the Central Rice Research Institute, Cuttack. Mr. Garg will arrange this.
- Recommendations (Annexure-B of this document) will be communicated to Pakistan participant seeking their concurrence. Mr. Garg will arrange this.
- The recommendations of the Workshop along with this Action Plan will be submitted to SASCOM for their information. Advice on steps necessary to formalize SA-CRAN and its linkage with the International Rice Research Network need to be specially sought from SASCOM. Background paper for discussion on this will be prepared jointly by Dr. Uprety, Mr. Garg and Dr. Tiwari and submitted to SASCOM for their advise.
- Dr. Uprety and Dr. Tiwari will prepare a proposal; to be submitted to ICAR for the creation and operation of an Indian sub-network of OTC sites involving all the Indian institutions that took part in this two year long APN funded programme.
- SASCOM will be requested to provide visiting fellowship to two scientists each in the participating countries so that a joint 2-week long training to them by Dr. Naveen Kalra on using OTC for modeling and impact assessment can be conducted. With the research infrastructure in place the most important need is capability building to assimilate experimental data in regional assessment and policy planning activities.

Annexure-A

Recommendations of the International Workshop of South Asian CO₂ Enrichment Rice Research Project *March 16-18th, 2001 IARI, New Delhi, India*

Background

The studies on response of crops growing under elevated CO₂ conditions were initiated in the South Asian region first in IARI, New Delhi through support by ICAR under National Fellowship programme. Funds for regional capacity building were given initially by START (1996-1998) and then by the Asia Pacific Network (1999-2001). The most important achievements of the APN funded phase were

- establishment of an operative network for conducting CO₂ enrichment experiments on rice crops in South Asia.
- operationalisation of one ring of a Mid-FACE facility at IARI New Delhi
- generation of preliminary data set on response of rice varieties to CO₂ enrichment
- development of a uniform protocol to generate data be used for cross country collaborative OTC experiments and its utilization as an input for modeling crop response
- establishment of an interface between the scientists and policy makers in these countries

During the project supplementary funding support was also provided by the respective institutions participating in the programme. Design and development support for the Mid-FACE and OTC kits was provided by NPL in association with scientists from Italy and Japan.

To review the progress made in this thrust area activity of SASCOM an “International Workshop of South Asian CO₂ Enrichment Rice Research Project”, was organized in New Delhi, India from 16th-18th March 2001 with support from NPL. Scientists from Bangladesh, India, Nepal, and Sri Lanka participated in this workshop. Scientists from Pakistan could not participate in this workshop due to some unavoidable reasons.

Detailed report of the APN project is attached.

Recommendations

Recognizing the importance of such a research and its applications in tackling regional issues arising from global change phenomenon of concern to the countries in the region, the following recommendation were made:

- Institutions that participated in the APN project and other institutions planning to undertake CO₂ enrichment research will be a part of a South Asian Regional network committed to carry out CO₂ enrichment research and application, to be formalized in consultation with SASCOM. This network will be tentatively referred to as “South Asian CO₂ Research and Application Network (SA-CRAN)”, till formalisation takes place. Other institutions of SASCOM region will be welcome to join it.
- There is a need to add more OTC stations in different agroecological zones within India and in other countries.
- Only one Mid-FACE ring has become operational at IARI at the moment. Resources are needed to put at least one more CO₂ control and two ambient rings at this site to make Mid-FACE facility establishment complete.
- Existing OTCs and Mid-FACE facilities will be used to carry out experiments for cropping seasons during the following one year period using internal resources.
- Meanwhile, efforts will be made by participants, collectively as well as individually, to obtain funds from various possible sources, national, regional or international, in addition to the efforts that may be made by SASCOM, to continue and grow CO₂ enrichment research infrastructure and activities.
- Subject to availability of resources, efforts will be made to expand the scientific scope of this multi country cooperative program to include, among others,
 - major crops of the participating countries,
 - ecosystems where they are grown,
 - bringing in expertise from other scientific and technological disciplines making it a multi-disciplinary programme linking agricultural and atmospheric sciences
 - initiation of application mode of results from OTC/Mid-Face experiments focusing on regional, global and cross sectoral impact assessment, adaptation and policy issues
- A consolidated data base emerging from CO₂ enrichment studies will be formalized at the earliest for regional use.
- The participants will pursue the above recommendations with their respective higher authorities as necessary.
- The acceptance of these recommendations by the institution in Pakistan which participated in the APN project will also be sought.

Signed by on March 18, 2001

PI, Bangladesh (Abdul Hamid)

PI, Nepal (S. Gurang) (K. K. Sherchan)

PI, Sri Lanka (W. J. A. M. de Costa)

PI, India (D. C. Uprety) (S. C. Garg)

PI, Pakistan (yet to be signed by Dr. M. Ashraf)

Annexure – B

OTC EXPERIMENTERS' PRE-WORKSHOP MEETING

1000 - 1700 Hrs, Friday, March 16, 2001

Venue: Plant Physiology Division, IARI

AGENDA

(Meeting chaired by Dr. A. M. Choudhury, Bangladesh)

*1. Welcome and Introductory Remarks - A. M. Choudhury
- S. C. Garg*

2. Exchange of experience: activity conducted and results

OTC experimentation at IARI - D. C. Uprety

Mid-FACE trial - H. K. Maini

Bangladesh - A. Hamid

Nepal - S. B. Gurang

Nepal - K. K. Sherchan

Tea Break

Pakistan - Md. Ashraf

Sri Lanka- W. J. A. M. de Costa

Other Indian institutions

Lunch Break

3. Discussion on assimilation of scientific output to be projected to APN

4. Discussion on resolving difficulties faced in conduct of OTC experiments

Arranging resources

Technical difficulties in OTC or CO₂ dissemination system operation

Following experimental protocol

Analysis phase

Resources requirement for next cropping season

Tea Break

5. Discussion on pursuing Mid-FACE experimentation

Schedule for operationalization

Funds for CO₂

Regional participation in initial experiments

Resources requirement for next cropping season

6. Any other items

Dinner

**INTERNATIONAL WORKSHOP OF
THE SOUTH ASIAN CO₂ ENRICHMENT RICE RESEARCH PROJECT
(Funded by APN; Organised by IARI, NPL and SAS-RRC)**

March 17-18, 2001

Venue:

**Inauguration at NRL Auditorium, IARI
Rest of the Sessions in Plant Physiology Division, IARI**

PROGRAMME

SATURDAY, MARCH 17, 2001

0930 - 1100 Hrs: Introductory Session (Chaired by Prof. Punjab Singh, Director, IARI)

Speakers:

Prof. G. C. Shrivastava, Head, Plant Physiology Division
Dr. A. P. Mitra, Director, SAS-RRC & Principal Investigator
Dr. Krishan Lal, Director, NPL
Prof. Punjab Singh, Director, IARI
Dr. D. C. Uprety, Co-Principal Investigator, IARI
Mr. S. C. Garg, Co-Principal Investigator, NPL
Representative from participating countries
Vote of Thanks

1100-1130 Hrs Tea Break

1130-1330 Hrs Session 2: Outcome of the Country Experiments

(Chaired by Dr. A. P. Mitra and Dr. K. L. Shreshtha)

Bangladesh: BBSMRAU: Dr. Abdul Hamid

Nepal: IAAS, Prof. S. B. Gurung

NARC: Dr. K. K. Sherchand

Pakistan: CSI: Dr. Md. Ashraf

Sri Lanka: Perideniya University: Dr. WJAM de Costa

Indian Institutions : Speakers to be decided

Talk on 'Utility of OTC data for modeling' - Dr. N. Kalra

Lunch break

1430-1730 Hrs Session 3: Requirements for the next cropping season and beyond

(Session conducted by Dr. M. K. Tiwari)

- Infrastructure & technical support
- Coordinated cropping activity
- Data for modeling & observational needs
- Training for modeling

- Logistic support
- Budgetary needs
- Potent sources and opportunities
- Policy interface
- Schedule

SUNDAY, MARCH 18, 2001 (0930-1530 Hrs)

0930-1200 Hrs Session 4: Working out protocol for regionally coordinated OTC experiments (Session conducted by Dr. Naveen Kalra)

In parallel the Core Drafting Committee consisting of Dr. M. K. Tiwari and Dr. Abdul Hamid drafted recommendations, follow-up plan and structure of report to be submitted to APN

Lunch Break

Presentation of the report and recommendations, signing formalities & conclusion

Annexure - C

**International Workshop of
South Asian CO2 Enrichment Rice Research Programme funded by APN**

List of Registered Participants

Bangladesh

Dr. A. M. Choudhury
SPARRSO
Dhaka, Bangladesh

Dr. Abdul Hamid
BSMR Agri. Univ.
Gazipur, Bangladesh

Dr. Md. Moynul Haque
BSMR Agri. Univ.
Gazipur, Bangladesh

Dr. Md. Sirajul Islam
Bangladesh Rice Research Institute
Gazipur, Bangladesh

Dr. Md Altab Hossain
Bangladesh Agri. Res. Institute, Gazipur, Bangladesh

Mr. Md. Abdus Salam
SPARRSO
Dhaka, Bangladesh

Nepal

Prof. K. L. Shreshtha
Ministry of S & T
Kathmandu, Nepal

Dr. K. K. Sherchan
NARC
Kathmandu, Nepal

Dr. Ghanashyam Malla
NARC
Kathmandu, Nepal
Prof. S B Gurang,
IAAS

Rampur, Nepal

Dr. N. K Chaudhary
IAAS
Rampur, Nepal

Dr. Suchit Shreshtha
NARC
Kathmandu, Nepal

Sri Lanka

Dr. W. A.J. M. de Costa
University of Peradeniya,
Sri Lanka

Dr. H. M. L.K Herath
University of Peradeniya,
Sri Lanka

Dr. Weerakoon WMW
Rice Res. & Dev. Institute
Sri Lanka

India other than IARI and NPL

Dr. M. J. Baig
IGFRI Jhansi

Dr. Padmini Swain
CRRI, Cuttuck

Dr. S. C. Joshi
G B Pant Institute, Garhwal

**Distinguished Invitees from outside
IARI and NPL**

Dr. K. N. Johry
NAM S & T Centre
New Delhi

Prof. Y. P. Abrol

Plant Physiologist,
Ex-IARI, New Delhi

Dr. I. P. Abrol
Director, CASA, New Delhi

NPL

Dr. A P Mitra
SAS-RRC New Delhi

Dr. Krishan Lal
Director, NPL New Delhi

Mr. S. C. Garg
NPL New Delhi

Dr. M. K. Tiwari
NPL New Delhi

Mr. H. K. Maini
NPL New Delhi

Mr. P. K. Gupta
NPL New Delhi

Dr. K. S. Zalpuri
NPL New Delhi

Mr. S. C. Gera
NPL New Delhi

Mr. H. N. Poddar
NPL New Delhi

Mr. Thomas John
NPL New Delhi

Mr. P. Subrahmanyum
NPL New Delhi

Ms. Madhu Bahl
NPL New Delhi

Dr. Sumana Bhattacharya
NPL New Delhi

Dr. C. Sharma
NPL New Delhi

Dr. Mahendra Mohan
NPL New Delhi

Ms. P Chopra
NPL New Delhi

Mr. Vishram Singh
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Mr. Dhan Singh
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Prof. Punjab Singh
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Dr. D. C. Uprety
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Dr. N. V. K. Chakarvarty
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Dr. Naveen Kalra
IARI New Delhi

Dr. D. C. Saxena
IARI New Delhi

Dr. Neeta Dviwedi
IARI New Delhi.

Mr. Rajat Mohan
IARI New Delhi

Prof. G. C. Srivastava
IARI New Delhi

Dr. U. K. Sengupta
IARI New Delhi

Dr. M. C. Ghildiyal
IARI New Delhi

Dr. Sunita Kumari
IARI New Delhi

Dr. Vanita Jain
IARI New Delhi

Dr. Madan Pal
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Prof. M. C. Jain
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Dr. M. Pandey
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Dr. P. S. Deshmukh
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Dr. Santosh Kumari
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Dr. V. P. Singh
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Dr. Ajay Arora
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Ms. Veena Singh Maurya
IARI New Delhi

Mr. Lalit Bhardwaj
IARI New Delhi

Mr. Mahesh Kumar
IARI New Delhi