

# Experts Consultation on Management of Abiotic Stress in Agriculture: Roadmap for Future Research and Education

## A Report



ICAR - National Institute of Abiotic Stress  
Management  
(Deemed to be University)

Malegaon, Baramati- 413 115, Pune, Maharashtra, India





**Experts Consultation on  
Management of Abiotic Stress in Agriculture:  
Roadmap for Future Research and Education**

**Proceedings of Meeting held on January 30-31, 2017**



**भाकृअनुप – राष्ट्रीय अजैविक स्ट्रेस प्रबंधन संस्थान**  
(समतुल्य विश्वविद्यालय)

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**ICAR - NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT**  
(Deemed to be University)

Malegaon, Baramati - 413 115, Pune, Maharashtra, India

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(समतुल्यविश्वविद्यालय)

ICAR - NATIONAL INSTITUTE OF ABIOTIC STRESS MANAGEMENT  
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Malegaon, Baramati- 413 115, Pune, Maharashtra, India

**Prof. Narendra Pratap Singh**  
**Director**



## Preface

National Institute of Abiotic Stress Management (NIASM) was established in 2009 to address agricultural constraints caused by factors such as drought, high temperature, salinity, waterlogging which are commonly referred as abiotic stresses. There are many more in the list which could be grouped into atmospheric, drought and edaphic classes. A large portion of cultivated area gets affected by these stresses at one point or other with varying degree of magnitude. Adverse impact of these stresses on agricultural productivity and livelihood is a major concern. Despite these constraints, abiotically affected areas, if attended with renewed scientific approaches can significantly contribute to national food security. Hence it was felt necessary to have an exclusive institute with Deemed to be University status for a deep insight into nature of stresses for the basic, strategic and adaptive research to help farmers in harsh environment and also to enhance capacity to manage such stresses through academic activities and training.

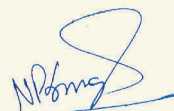
Having spent its initial seven years in developing infrastructure and research facilities, this unique institute is now ready to expand its preliminary research into full fledged projects on abiotic stress in crops, livestock and fisheries. Since every research institute associated with agriculture is giving due priority to this aspect, it was decided to have a close interaction between the scientists and experts to develop a road map through consultation meeting. Consequently, invitations were sent to experts in different institutes under ICAR for discussion.

The main objective of the meeting was to know about abiotic research in progress at other institutes, expectations of other institutes from ICAR-NIASM and possible opportunities for research collaboration to avoid duplication and to establish synergy in achieving the common goal of abiotic stress management for the cause of farmers in harsh environments.

The present proceedings report the deliberations of the Expert Consultations and expected to provide framework for future research on abiotic stress through collaboration between the institutes. I express my thanks to the participants in general and Directors of the institute in particular for providing their inputs and sharing information. I sincerely thank Honourable Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR), I also express my gratitude to Dr. S.P. Kimothi, ADG (Technical. Coordination) for supporting this consultation meeting.

I express my gratitude to all my colleagues who worked hard to organize this meeting and to compile the proceedings. I hope that this well synthesized report will be useful to all the concerned institutions/organizations engaged in abiotic stress research in agriculture and particularly for ICAR-NIASM scientists.

Dated: March 25, 2017  
ICAR-NIASM, Baramati

  
(Narendra Pratap Singh)  
Director

# Abbreviations

|         |   |
|---------|---|
| CARI    | Central Agroforestry Research Institute                     |
| CCARI   | Central Coastal Agricultural Research Institute             |
| CIAE    | Central Institute of Agricultural Engineering               |
| CIAH    | Central Institute for Arid Horticulture                     |
| CIBA    | Central Institute of Brackish water Aquaculture             |
| CIFA    | Central Institute of Freshwater Aquaculture                 |
| CIFE    | Central Institute of Fisheries Education                    |
| CIFRI   | Central Inland Fisheries Research Institute                 |
| CIMFRI  | Central Marine Fisheries Research Institute                 |
| CIRCOT  | Central Institute of Research on Cotton Technology          |
| CISH    | Central Institute of Sub Tropical Horticulture              |
| CSSRI   | Central Soil Salinity Research Institute                    |
| DMAPR   | Directorate of Medicinal and Aromatic Plants Research       |
| DOGR    | Directorate of Onion and Garlic Research                    |
| DPR     | Directorate of Poultry Research                             |
| HTP     | High Through Put  |
| IIMR    | Indian Institute of Millets Research                        |
| IIPR    | Indian Institute of Pulses Research                         |
| IISR    | Indian Institute of Soybean Research                        |
| IISR    | Indian Institute of Sugarcane Research                      |
| IISWC   | Indian Institute of Soil and Water Conservation             |
| IIVR    | Indian Institute of Vegetable Research                      |
| IIWBR   | Indian Institute of Wheat and Barley Research               |
| IVRI    | Indian Veterinary Research Institute                        |
| NBAIM   | National Bureau of Agriculturally Important Micro-organisms |
| NBSSLUP | National Bureau of Soil Survey and Land Use Planning        |
| NDRI    | National Dairy Research Institute                           |
| NIASM   | National Institute of Abiotic Stress Management             |
| NRCG    | National Research Centre for Grapes                         |
| NRCP    | National Research Centre on Pomegranate                     |
| NRRI    | National Rice Research Institute                            |
| RCNEH   | ICAR Research Complex for NEH Region                        |
| VIGS    | Virus Induced Gene Silencing                                |

## Introduction

Abiotic stresses such as drought, salinity and extreme temperature together with the growing population and per capita food consumption are challenging sustainability of food security. With substantial water consumption in agriculture, quality and quantity of ground water is becoming more critical for human as well as soil health. With 1/3 of the geographical area prone to degradation due to soil erosion, flood, waterlogging etc. expansion of agricultural land is a remote possibility. With 2/3 of the cultivated area prone to drought, uncertainty looms large over stability of food production and price. Climate change and the continuing atmospheric CO<sub>2</sub> rise are adding new dimensions to abiotic stress which have recently become more common cause of distress in farming families. Consequence of adverse impact of drought on agricultural crops and forages are evident even in livestock production and also reflect in reduction in inland fisheries. Recent research is uncovering complexity of harsh agro-ecologies through remote sensing and GIS based science, adaptation options through combination of key traits and genes for genetic improvement in tolerance to stress, mitigation options through conservation agriculture and biomolecules, and conducive environment for technology adoption through policy research. Furthermore, continuing plans are being developed to cope with the predicted devastating effects of climate change on agriculture.

ICAR-NIASM is a National Institute and emerging leader in addressing abiotic stresses in food, vegetable and fruit crops, livestock and fisheries. This is further evidenced by the earlier workshops/ conference/ training programmes, successfully conducted by this Institute. The institute had curtain raiser meet on research need arising due to abiotic stresses in agricultural management in India under global climate change scenario (October 29-30, 2010). This was followed by consultant meet on abiotic stress management in animal sciences (November 19-20, 2010). This was followed by expert consultancy on gaps in research on abiotic stress management in crops under climate change scenario (August 24-25, 2011) and expert consultancy meeting on early arrowing in sugarcane (January 9-10, 2012). The institute had also an opportunity to host Agriculture University, Directors Conference held in January 17-18, 2014. All these meeting enabled the institute to periodically review and reorient its research programme. Consequently, the institute has now research projects on following aspects

- Understanding the abiotic stress environments
- Options for mitigation of stress in crops, livestock and fish
- Options for improving adaptation to stress
- Policy support for stress management

## **Aims and Objectives**

The present meeting was aimed at the recent advances in abiotic stress research in ICAR institutions dealing with different commodities and natural resource management aspects. This was organized to have a glance at the information generated or documented at different institutes and commodities. The discussions were largely oriented towards the priorities in abiotic stress research, mitigation and adaptation options for management of abiotic stresses and way forward for future research and education.

## **Relevance of theme**

The theme has a distinct relevance to the ICAR-NIASM mandate of undertaking basic and strategic research on management of abiotic stresses of crop plants, animals, fishes and microorganisms through genetic, biotechnological and nano-technological tools and through conservation agriculture methods for enhanced and sustainable productivity, food/feed quality and farm profitability through inter-disciplinary and inter-institutional approaches

## **Structure of the theme and resource persons**

The brain storming session included presentation by experts in wide range of discipline with focus on efforts to understand abiotic stress environment, options for mitigation of stress, approaches for improving adaptation to stress and policy support for adoption of technologies. There were 5 sessions including the inaugural and plenary sessions. The other three sessions were carried out in parallel involving three groups of expertise viz. Natural Resource Management, Crop and Horticultural Sciences and Animal and Fisheries Sciences. Each session had a brief key note address followed by brief presentation and detailed discussion. About 40 participants including those from institute participated in this meeting.

# Management of Abiotic Stress in Agriculture : Roadmap for Future Research and Education



## Inaugural Program

The programme started with opening remark by Prof. Narendra Pratap Singh, Director, ICAR-NIASM, Baramati. He welcomed all the distinguished experts from different institutes. He explained



the house about the genesis of the Experts Consultation Meeting. He highlighted that NIASM has well developed research farm and research laboratory facilities equipped with state-of-art and high end equipments to carry out research for advancement of agricultural research for delivering technologies for benefit of farmer's community and basic and strategic research to address issues of various kinds of abiotic stresses. He also emphasized that teaching courses should be started since this institute came into existence as Deemed to be

University.



Dr. P.S. Minhas, Emeritus Scientist, ICAR-CSSRI & Ex-Director, ICAR-NIASM, in his address, highlighted that land inherited to this institute was a barren patch of rocky land and there was a big challenge to convert this land into a research farm to demonstrate soil and water management technology. He emphasized that this institute has been able to convert barren land into one of the best experimental farm for research to address issues associated with abiotic stress management with respect to the crops,

horticulture, animal sciences including fisheries. In his address he emphasized that now this institute is ready to go into a networking mode and also to take lead in research for management of abiotic stresses employing advanced basic and strategic research and developing technologies that can be transferred to the farmers. Since, this institute has well developed model research farm and research laboratories equipped with state-of-art equipments, now this institute can be a hub for knowledge sharing and learning. He hoped that NIASM will emerge as global centre of excellence on abiotic stress management research.

# Session-I: Natural Resource Management (NRM)

Following experts attended the meeting and made presentations on various aspects regarding research and education on abiotic stress.

- Chairman : Dr. P. S. Minhas, Emeritus Scientist, CSSRI, Karnal  
Co-Chair : Prof. Narendra Pratap Singh, Director, NIASM, Baramati  
Rapporteur 1 : Dr. K. K. Krishnani, Head-SESM, ICAR-NIASM, Baramati  
Rapporteur 2 : Dr. K. K. Meena, Senior Scientist, ICAR-NIASM, Baramati

## Participants from different ICAR-Institutions

1. Dr. A. K. Saxena, Director, NBAIM, Mau
2. Dr. V. K. Mishra, Head, CSSRI, Lucknow
3. Dr. P. R. Ojasvi, Head, IISWC, Dehradun
4. Dr. K. N. Agrawal, PC, CIAE, Bhopal
5. Dr. Badre Alam, Pr. Scientist, CARI, Jhansi
6. Dr. S. V. Ghadge, Sr. Scientist, ICAR-CIRCOT, Mumbai
7. Dr. U. K. Maurya, Sr. Scientist, IISWC, Dehradun
8. Dr. Rahul Tripathi, Scientist, NRRI, Cuttack
9. Dr. Ashis Maity, Scientist, NRCP, Solapur
10. Dr. G. P. Obi Reddy, PS, NBSSLUP, Nagpur

## Proceedings in brief

Dr. P. S. Minhas (Chairman) raised the issues related to edaphic stresses including low organic carbon leading to degradation of the soil physical and chemical properties, nutrient deficiencies, soil salinization due to over irrigation and dry land salinity due to rain fed conditions, acidic soil and soil erosion. Dr. N. P. Singh stressed the need of mitigation of priority edaphic stresses using multi-disciplinary approaches. Dr. A.K. Saxena (Director, NBAIM), emphasized the need of harnessing plant growth promoting endophytic and epiphytic microbes associated with the extremophytic wild vegetation and xerophytes for developing the biomolecules based technology to enhance crop productivity under stressed environments. This was followed by a series of presentations by other participants and discussion to arrive at possible collaboration and recommendation for future research.

## Priorities and collaboration

### 1. Stress mitigation through conservation agriculture

RCTs, water and nutrients use efficiency in rain-fed agriculture, carbon sequestration potential and other potent greenhouse gases mitigating effect of conservation agriculture based systems, precision farming and organic farming may be carried out in collaboration with ICAR Institutes (IISS, CSSRI, NRRI, IISWC, CIAE, CARI)

### 2. Favourable plant-microbe interaction to alleviate stress

Advance research on the extremophiles and xerophytes associated endophytic and epiphytic microbes and microbial consortia and plant growth promoting biomolecules based technology should be carried out in collaboration with NBAIM and NIBSM.

### **3. Rapid methods for screening of germplasm for salinity tolerance**

Rapid methods should be developed for screening of large number of germplasm for salinity tolerance in collaboration with ICAR Institutes (NRCP, IISS, CSSRI, NRI). Salt affected soils in Maharashtra may be delineated.

### **4. Multiomic approach to address edaphic stresses**

System biology approach including multi-omics, and diverse methods such as molecular, biological, biochemical, microbiological, bio-analytical to address edaphic stresses i.e. shallow soil, soil erosion, nutrient deficiency, salinity, alkalinity/sodicity, acidity, contaminants (POPs, and PBTs, Fluorides, heavy metals including arsenic speciation), low organic carbon and waterlogging should be promoted in collaboration with ICAR Institutes (CSSRI, IISS, CIFRI, CIBA) and CSIRO.

### **5. Nano-Biotechnological applications for stress mitigation**

Novel methods should be developed for synthesis of nanostructured materials for multiple stress resilience in field & horticulture crops, livestock & fisheries in collaboration with ICAR Institutes (CIRCOT, CIFA, CIBA, IARI, CSSRI). Feasibility of native zeolite / nano zeolite for slow release of water and nutrients and for remediation of water under abiotic stress environment should be explored in collaboration with ICAR Institutes (NRCP, IISWC). Research should also focus on the development of nano(bio)sensors for measurement of important physic-chemical soil and water quality parameters including micronutrients in collaboration with ICAR institutes (CIAI, IISS, NIBSM), other Institutes (NPL-New Delhi, ARI-Pune, IIT-Chennai, University of California-Riverside).

### **6. Mapping abiotic stresses (NBSLUP)**

It is essential to characterize abiotic stress environment and map those environment across the countries.

## **Recommendations**

1. Conservation agriculture based systems should be developed for mitigation of edaphic stresses, particularly in the rainfed agriculture. Carbon sequestration and other potent greenhouse gases mitigating effect of CA based systems should also be assessed.
2. The extremophytic wild vegetation and xerophytes should be targeted for obtaining the associated plant growth promoting endophytic and epiphytic microbes and for developing the biomolecules based technology to enhance crop productivity under stressed environments.
3. Nano(bio-)technological interventions should be undertaken for multiple stress resilience in field & horticulture crops, livestock & fisheries. Focus should also be on the development of nano(bio)sensors for monitoring stress related parameters.
4. Basic and strategic research related to integrated farming systems, precision farming and organic farming should be undertaken for multiple stress resilience
5. Research priority should be on efficient nutrient and water management in salt affected soils, water deficit, sub-merged condition and futuristic climatic variability conditions. Rapid methods should be developed for screening of large number of germplasm for salinity tolerance.

# Session-II: Crop Improvement and Horticultural Sciences

## A. Crop Improvement

Following experts attended the meeting and made presentations on various aspects regarding research and education on abiotic stress.

- Chairman : Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow  
Co-Chair : Dr. H. S. Talwar, Pr. Scientist, ICAR-IIMR, Hyderabad  
Rapporteur 1 : Dr. D. P. Patel, Pr. Scientist, ICAR-NIASM, Baramati  
Rapporteur 2 : Dr. Ajay K. Singh, Sr. Scientist, ICAR-NIASM, Baramati

### 1. Presentations: Crop Science

1. Dr. Jagadish Rane, Head & Pr. Scientist, ICAR-NIASM, Baramati
2. Dr. Ratan Tiwari, Pr. Scientist, ICAR-IIWBR, Karnal
3. Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow
4. Dr. H. S. Talwar, Pr. Scientist, ICAR-IIMR, Hyderabad
5. Dr. P. S. Basu, Pr. Scientist, ICAR-IIPR, Kanpur
6. Dr. G. K. Satpute, Sr. Scientist, ICAR-IISR, Indore
7. Dr. Krishnappa R., Scientist, ICAR-RCNEH, Umiam, Meghalaya

### 2. Other Participants

1. Dr. Mamrutha, Scientist, ICAR-IIWBR, Karnal
2. Dr. Ganapati, Pr. Scientist, ICAR-IIMR, Hyderabad
3. Dr. K.K. Sharma, Pr. Scientist, ICAR-IIMR, Hyderabad, RS. Sholapur
4. Dr. Mahesh Kumar, Scientist, ICAR-NIASM, Baramati
5. Dr. Prashantkumar S Hanjagi, Scientist, ICAR-NIASM, Baramati
6. Dr. Ramteke, Pr. Scientist, ICAR-NRCG, Pune

## Proceedings in brief

The meeting started with the presentation by Dr. Jagadish Rane, Head and Pr. Scientist & Head, ICAR, NIASM, Baramati, who highlighted the research work done and facilities available at ICAR-NIASM, for information of the participants, followed by address of the Chairman, and presentations from different experts. Much of the discussion revolved around major abiotic stresses such as drought, high and low temperature, waterlogging and soil salinity/soil acidity. Strategies were suggested for possible research collaboration and the following recommendations were emerged after thorough discussions.

## Priorities and collaboration

### 1. Inter-institutional programmes for alleviating abiotic stresses in crop plants

- ICAR- NIASM should act as key partner for developing screening protocols for tolerance to drought, heat and waterlogging stresses in wheat (ICAR-IIWBR), chickpea (ICAR-IIPR), sorghum/millet (ICAR-IIMR), soybean (ICAR-IISR) and sugarcane (ICAR-IISR; ICAR-SBI)
- Development of cost effective phenomics tools to screen for tolerance to drought, heat, waterlogging, salinity and acidity in crops
- Development of research programmes for studies on root traits under above mentioned stresses in soybean, wheat, chickpea, and sorghum.

## Recommendations

### 1. Extending facilities at National Centre for Plant Phenomics to other institutes

- To validate traits associated with drought and heat stress tolerance in Sorghum and millets (ICAR-IIMR), wheat, (ICAR-IIWBR), chickpea (ICAR-IIPR), soybean (ICAR-IISR) and tolerance to acidic soil (ICAR-NEH-RS)

### 2. Elucidation of function of genes associated with drought and heat stress tolerance

- Using Virus Induced Gene Silencing (VIGS) and RNAi approaches in soybean, chickpea and wheat

### 3. Realizing NIASM as key information centre on abiotic stresses

- By collecting information from different national/international institute involved in tolerance to abiotic stresses in crop plants; national institutes will provide all the published literature on respective crops
- By maintaining repository of known tolerant lines/genotypes for drought, heat, waterlogging etc and keeping a close link with ICAR-CSSRI for salinity tolerance
- By harnessing basic research work published by CSIR / DST / BARC and other Labs particularly to mitigate heat, drought and waterlogging stress on crops; for example novel human and environment friendly bioregulators taking into considerations utility for farmers
- By collaborating with ICAR-IASRI, New Delhi for computational analysis of multi-center / multi-environmental / multi-crop data and its interpretation
- By using the above information for capacity building to manage crops under drought, heat, waterlogging particularly for
  - Assessing the responses of plants to drought, heat, waterlogging and hailstorm
  - Assessing the efficacy of bio-regulators in alleviating above stresses in plants
  - Designing the experiments for the purposes mentioned above

## B. Horticultural Sciences

Chairman : Dr. Bijendra Singh, Director, ICAR-IIVR, Varanasi

Co-Chairman : Dr. Jitender Kumar, Director ICAR-DMAPR, Anand

Rapporteur-1 : Dr. S. K. Bal, Pr. Scientist, ICAR-NIASM, Baramati

Rapporteur-2 : Dr. Yogeshwar Singh, Sr. Scientist, ICAR-NIASM, Baramati

### Presentations: Horticulture

1. Dr. Yogeshwar Singh, Sr. Scientist, ICAR-NIASM, Baramati
2. Dr. Jitendra Kumar, Director, ICAR-DMAPR, Anand, Gujarat
3. Dr. S. Rajan, Director, ICAR-CISH, Lucknow
4. Dr. Bijendra Singh, Director, ICAR-IIVR, Varanasi
5. Dr. B. D. Sharma, Head and Pr. Scientist, ICAR-CIAH, Bikaner
6. Dr. Pranjali H. Ghodkhe, Scientist, ICAR-DOGR, Pune
7. Dr. A. Thangasamy, Scientist, ICAR-DOGR, Pune
8. Dr. S. S. Sawant, Director, ICAR-NRCCG, Pune
9. Dr. Anuradha Upadhyay, ICAR-NRCCG, Pune
10. Dr. K. Dhinesh Babu, ICAR-NRCP, Solapur

### Proceedings in brief

The meeting started with the presentation by Dr. Yogeshwar Singh, Senior Scientist, ICAR-NIASM, Baramati, who presented the research works done and facilities available at ICAR-NIASM which includes background information of on-going research work at ICAR-NIASM followed by address of the Chairman and presentations from various delegates. Issues related with abiotic stresses in horticultural crops such as edaphic, atmospheric, drought, high and low temperature, waterlogging and soil salinity/soil acidity were discussed in detail. Strategies were suggested for possible research collaboration and the following recommendations were emerged after thorough discussions.

### Priorities and collaboration

1. Standardization of water saving techniques/irrigation strategies for various horticultural crops to maximize water productivity of crop under various abiotic stress condition (NRCP, NRCCG; IIVR and DOGR)
2. Development of abiotic stress description/rapid screening of genotypes for abiotic stresses such as high temperature, soil moisture stress and waterlogging through phenomics facility and other tools (NRC Pomegranate, CISH Mango, DMAPR-Medicinal and aromatic plants, IIVR-especially tomato, DOGR-onion and garlic)

3. Quantifying beneficial effects of abiotic stresses in terms of secondary metabolites, antioxidants, other qualitative parameters (DMPAR, NRC Grapes, NRC Pomegranate and CIAH for Apple Ber)
4. Standardizing the design for low cost protected structures/greenhouse for high value crops like Grapes, Pomegranate, Cherry Tomato in collaboration with NRCG, NRCP & IIVR; respectively.

## Recommendations of the session

1. Emphasis for understanding role of root stock, root structure and its behaviour in horticultural crops under drought and edaphically stressed conditions.
2. Delineating microclimate environment inside protected structures and quantifying its impact on high value horticultural crops like pomegranate, grapes, tomato, capsicum, etc.
3. Quantifying beneficial effects of abiotic stresses in terms of secondary metabolites, antioxidants, other qualitative parameters and inclusion of suitable medicinal/aromatic plants in farming system for harsh agro-ecosystems.
4. Standardization of PRD technique for various horticultural crops to maximize unit water productivity.
5. Development of post-hail management practices for various horticultural crops namely pomegranate, grape, onion etc.
6. Development of abiotic stress descriptors/rapid screening of genotypes for abiotic stresses through phenomics facility and other tools for crops like pomegranate, mango, medicinal and aromatic plants, vegetable crops especially tomato and onion.
7. Management of physiological disorders and problems associated with abiotic stresses
  - Crop regulation in guava for flowering manipulation
  - Malformation and alternate bearing problem in Mango
  - Pink berry in Grapes
  - Fruit cracking and sunscald in pomegranate



## Session III: Animal and Fisheries Sciences

- Chairman : Dr. S. M. K. Naqvi, Director, ICAR-CSWRI, Avikanagar  
Co-Chairman : Dr. N. V. Patil, Director- ICAR-NRCC, Bikaner  
Rapporteur 1 : Dr. N. P. Kurade, Pr. Scientist, ICAR-NIASM, Baramati  
Rapporteur 2 : Dr. M. P. Brahmane, Sr. Scientist, ICAR-NIASM, Baramati

### Presentations from different ICAR-Institutions:

1. Dr. E. B. Chakurkar, Director (A), ICAR-CCARI, Goa
2. Dr. Sohanvir Singh, Nodal Officer-NICRA, ICAR-NDRI, Karnal
3. Dr. K. N. Bhilegaonkar, Pr. Scientist & SIC, Regional Station, ICAR-IVRI, Pune
4. Dr. Subodh Gupta, Pr. Scientist, ICAR-CIFE, Mumbai
5. Dr. U. Rajkumar, Pr. Scientist, ICAR-DPR, Hyderabad
6. Dr. V. R. Suresh, Head & Pr. Scientist, ICAR-CIFRI
7. Dr. Hirak Kumar Barman, Pr. Scientist, ICAR-CIFA, Bhubaneswar
8. Dr. Tanveer Husain, Scientist, ICAR-CIBA, Chennai
9. Dr. Ratheesh Kumar R, Scientist, ICAR-CIMFRI, RS, Mumbai

### Proceedings in brief

The meeting started with the address and presentation of the Chairman, followed by the address of the Co-Chairman and presentations from different experts. After thorough discussion the following major stressors were identified to be addressed by ICAR-NIASM in animals and fisheries.

Dr. S. M. K. Naqvi (Director, ICAR-Central Sheep and Wool Research Institute, Avikanagar) talked about addressing the anticipated challenges in abiotic stress through developing research linkages. He suggested the need for strengthening infrastructure and human resource of ICAR-NIASM to make it leader in abiotic stress research in our country. This was followed by presentations by different institutes of animal and fisheries sciences.

### Recommendations

1. There is strong need for initiation of AICRP (All India Coordinated Research Project) on Abiotic stress in animals and fish separately with ICAR-NIASM as a lead centre and species specific ICAR-Institutes as collaborating centres.
2. Infrastructure: establishment of following facilities for strengthening research and education in abiotic stress
  - a. Controlled climate chamber for stress studies in animals and fisheries.
  - b. Advanced high throughput facilities for genomic, proteomic, metabolic, cellular and molecular studies.

- c. High performance computing facility for data analysis.
- d. Specialized software's for abiotic stress studies.
- e. Central Database facility for abiotic stress data in animals and fisheries.
- f. Facilities for Tele-measuring and GIS for stress response in animals and fisheries.

### Priority areas and research collaboration livestock

1. Thermal stress (Heat, cold and radiation)  
Cattles (ICAR-NDRI, ICAR-IVRI, ICAR-CCARI), Goat (ICAR-CIRG, ICAR-CCARI),  
Sheep (ICAR-CSWRI), Poultry (ICAR-DPR, ICAR-CARI), Camel (ICAR-NRCC)
2. Nutritional stress (quality and quantity)  
Cattles (ICAR-NDRI, ICAR-IVRI), Goat (ICAR-CIRG, ICAR-CCARI),  
Poultry (ICAR-DPR, ICAR-CARI)
3. Water stress (quality and quantity)  
Cattles (ICAR-NDRI, ICAR-IVRI, ICAR-CCARI)
4. Transportation stress  
Cattles (ICAR-NDRI, ICAR-IVRI, ICAR-CCARI),

### Suggested Research Programmes

1. Development of indices for quantifications of abiotic stress in animals and fishes (ICAR-NDRI, ICAR-IVRI, ICAR-CIFE, ICAR-CIFA )
2. Identification of physiological, biochemical and genetic markers for thermal and nutritional stress (ICAR-IVRI, ICAR-NDRI, ICAR-NBAGR, ICAR-CICR, ICAR-NBFGR ICAR-CIFE, ICAR-CIFA)
3. Behavioral studies for thermal, hypoxia and migratory stress in animals and fishes (ICAR-NDRI, ICAR-IVRI, ICAR-CMFRI, ICAR-CIFRI)
4. Impact of thermal, nutritional and hypoxia stress on vulnerability to disease in animals and fishes (ICAR-IVRI, ICAR-CIFE, ICAR-CIFA, ICAR-CIRG, ICAR-CSWRI)
5. Reproduction and fertility studies in relation to effect of thermal and nutritional stress (ICAR-NDRI, ICAR-CIRC , ICAR-CIBA, ICAR-CIFA)
6. Neonatal mortality in animals and early life stages mortality in fishes induced by thermal and nutritional stress (ICAR-NDRI, ICAR-CCARI, ICAR-CSWRI, ICAR-CIRG, ICAR-DPR, ICAR-NRCC)

## Session IV: Plenary Session

- Chairman : Dr. P. S. Minhas, Emeritus Scientist, ICAR-CSSRI  
Co-Chairman : Prof. Narendra Pratap Singh, Director, ICAR-NIASM  
Rapporteur-1 : Dr. K. K. Krishnani, Pr. Scientist & Head, ICAR-NIASM  
Rapporteur-2 : Dr. S. K. Bal, Pr. Scientist, ICAR-NIASM  
Participants : Scientists from all the session

In this session there was a brief presentation about the institute research activities by Dr Jagadish Rane, Head, School of Drought Stress Management and OIC- PME. Recommendations of the experts from different sessions were presented by the Rapporteurs. It was suggested by the Chair that the recommendation to be reoriented to highlight the research priorities and the action to be taken for different crops and abiotic stresses in collaboration with other research institutes.

This session discussed in detail the academic activities to be carried out by the institute. It was general opinion that the institute should initiate its own academic programme by following all the formalities. The other school of thought suggested that to start with the institute can collaborate with existing Deemed to be Universities under ICAR and gradually shift to its own system.

It was suggested that recommendations from experts to be reoriented to reflect the collaborative research programmes with different institutes and priorities research areas so that it can serve as framework for future research and academic activities.

The meeting ended with vote of thanks to all by Dr. Jagadish Rane.

### Recommendations

1. Students should be attracted for research driven teachings for PG and Ph.D. programmes. This may be achieved through MOUs with nationally and internationally reputed Universities/ Academic Institutions/Students Exchange programme/Sandwich mode/Fellowship in collaboration with other ICAR & Non-ICAR Institutes and SAU's for partial fulfillment of PG degree. PG degree may be offered in the field of Environmental biotechnology covering various abiotic stresses in Field & horticulture crops, livestock & poultry and Fisheries.
2. There should be provision for international trainings to scientific staff in cutting edge areas of abiotic stress research in animals and fisheries.
3. Focus of ICAR-NIASM should be on basic and fundamental studies at cellular and molecular levels to complement applied research done in other institutes.
4. Different experts/ Institutes to be consulted for course curriculum development for future education programmes.
5. To strengthen the research and academic activities, there is a need to strengthen man power for animal sciences and fisheries component of the institute. There should be at least 3 scientists each of animal and fisheries science in each School of the Institute (12 Animal Science and 12 Fisheries Sciences Scientists). The disciplines such as Animal Biotechnology, Animal Physiology, Animal Nutrition, Livestock Production & Management, Animal Reproduction, Veterinary Pathology, Aquaculture, Fish Nutrition and Biochemistry and Biotechnology should be included in the cadre strength.

# Research Highlights

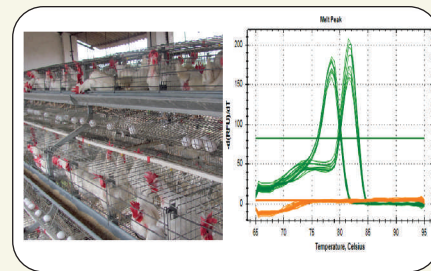
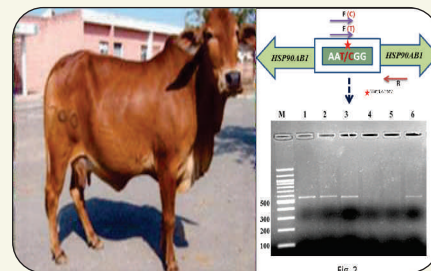
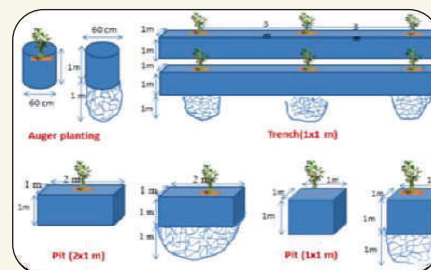
## School of Atmospheric Stress Management

### Objectives

- Quantifying the impact of elevated CO<sub>2</sub>, heat/cold etc. on food and horticultural crops, livestock and fisheries
- Adaptive and mitigation strategies for atmospheric brown clouds
- Elucidating molecular basis of adaptation using “omics” approach
- Developing Decision Support System for managing the extreme weather events

### Research Highlights

- Quantified CO<sub>2</sub> and heat fluxes from crop ecosystems of shallow edaphically stressed soil environment using Eddy Covariance method
- Identified indeterminate soybean as an mitigation option for reduced PAR and increased number of cloudy days
- Evaluated role of spent wash and promising cropping sequence for murrum disintegration
- Identified bio-regulator as an option for recovery of hail damaged crops
- Identified bio-regulator as an option to alleviate water stress in wheat, soybean and sorghum crops
- Identified suitable agro-chemicals to overcome water logging stresses in *Kharif* Onion
- Developed sub-surface water harvesting method by micro-blasting technology to alleviate edaphic and drought stresses for fruit orchards
- Developed methods for identification of SNP genotypes in Heat Shock Protein (HSP) genes of indigenous and cross bred dairy cattle Identified temperature and hypoxia responsive genes in fish
- Developed new machine for stubble shaving, off barring/root pruning and fertilizer application in ratoon sugarcane to minimize the cost and energy in existing ratoon management technologies
- Polymorphism analysis and gene expression studies in response to heat stress in poultry.



# School of Drought Stress Management

## Objectives

- Investigations on physiological manifestations, signal transduction and regulation of stress responsive genes.
- Development of screening protocols for traits and genes relevant to stress tolerance.
- Use of genomics, phenomics, proteomics and metabolomics tools.
- Plant-endo/rhizo bacteria interactions for alleviating stress.

## Research highlights

### Phenotyping tools and protocols

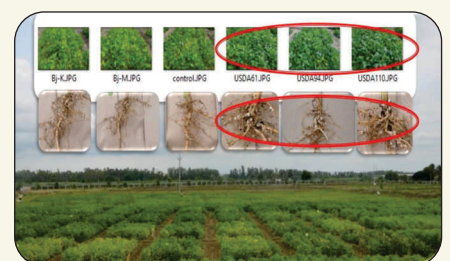
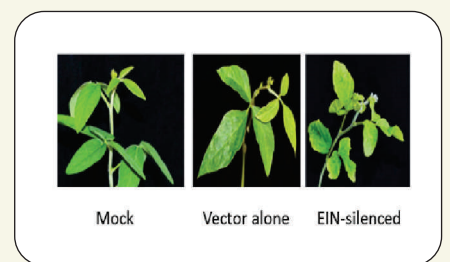
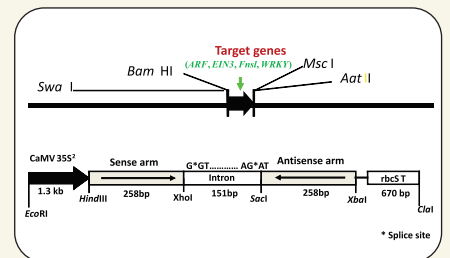
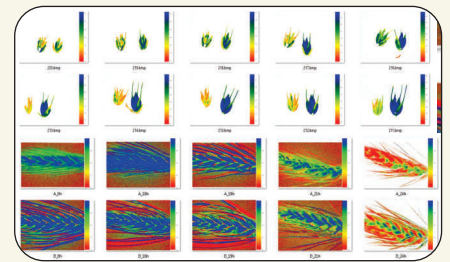
- Plant Phenomics facility has been established at the institute for precise screening of genotypes of crop plants for different stresses such as drought and high temperatures.
- HTP image acquisition and image analysis optimized for crops such as soybean and mungbean.
- Prototypes of low cost indigenous phenotyping tools developed for canopy temperature and leaf senescence.
- Optimized Chlorophyll fluorescence based technique revealed more tolerance in *T. durum* than in *T. aestivum*.
- Chlorophyll fluorescence can be used as stress indicator in crop plants
- Chlorophyll fluorescence images revealed more tolerance to desiccation in dragon fruit and lime than in mango.

### Promising genes, traits and genotypes

- *In vitro* protocols developed to assess variation in root traits in wheat, mungbean and soybean.
- Three promising wheat genotypes viz. IC-549394, EC-573623 and IC-112051 for limited soil moisture conditions.
- BPMV-based VIGS vector was constructed to silence Ethylene-insensitive, *ADP riboxylation factor*, *WRKY-39* and *WRKY-49* genes in soybean.
- RNAi construct was developed to generate stable silenced lines for EIN and Farnesyl transferase genes.

### Drought mitigation options

- *Bradyrhizobium* with *Rtx* gene improved soybean yield in murrum soil by enhancing nodules and N-fixation.
- Sorghum endophytes with multi-PGP traits confer water stress tolerance.
- Water saving technique revealed that regulated deficit irrigation (RDI0.8 i.e. 0.8xETc) did not affect the marketable fruit yield of tomato as compared with the full irrigation (FI; 78.0 Mg ha<sup>-1</sup>). The water productivity of 19.2 kg m<sup>-3</sup> was the maximum under RDI0.8.



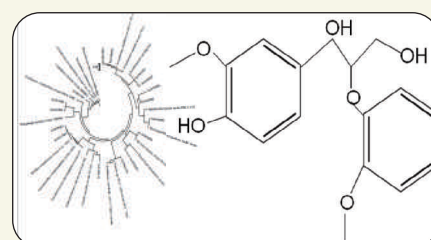
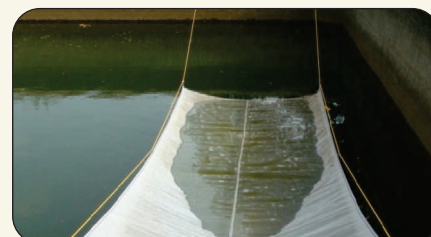
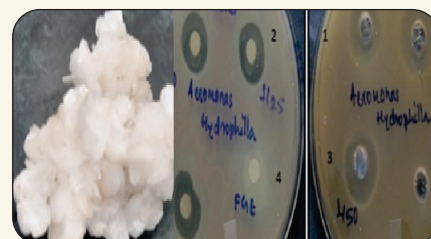
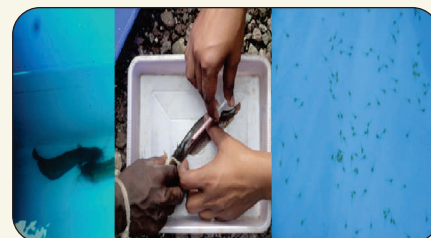
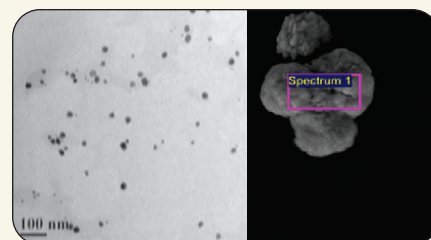
# School of Edaphic Stress Management

## Objectives

- Genetic and molecular basis of tolerance and ion homeostasis under salinity, nutrient deficiencies, pollutants, anoxia etc.
- Application of soil meta-genomics, nanotechnology and system biology
- Assessing soil as a sink for greenhouse gases
- Conservation/precision agriculture as adaptive tools for stress environments

## Research Highlights

- Multi-purpose machine for improving nitrogen-use efficiency through N application methods under surface retention of trash
- Process for the synthesis of nanostructured materials using fisheries wastes (Patent 3255/MUM/2012)
- Metagenomic method for examination of unculturable microbial diversity of saline soils
- Standardization of rapid method for quantitative detection of IAA and IBA
- Microbially derived polymeric product for gel formation, microbial colonization and metals binding (Patent 3127/MUM/2015)
- Aluminosilicate based nanocomposites for alleviation of multiple abiotic and biotic stresses
- Nanoparticles as fish feed additive for bactericidal activity
- Nutri-remediation for mitigation of multiple stressors
- Protocol for breeding and seed production of *Heteropneustes fossilis* (Shinghi)
- Protocol for evaluating lignin degrading bacteria
- Protocol for heavy metals assessment and enzyme based protocol as biomarkers for monitoring heavy metals contamination in aquatic bodies
- Hapa culture of fish using intermediary water of agriculture
- Techniques to obviate edaphic stresses in orchards grown on shallow basaltic soils



# School of Policy Support Research

## Objectives

- Policy research to promote adoption of techniques for adaptations to abiotic stress
- Designing novel management options that provide opportunity for stress mitigation and carbon trading

## Research highlights

- The trend and seasonal movement of price and arrival of major onion wholesale markets of Maharashtra worked out
- The relation between climate variables and area, production, productivity of onion in Maharashtra worked out using time series and cross sectional data
- Perception of different categories of onion growers to climate variables in Maharashtra has been assessed

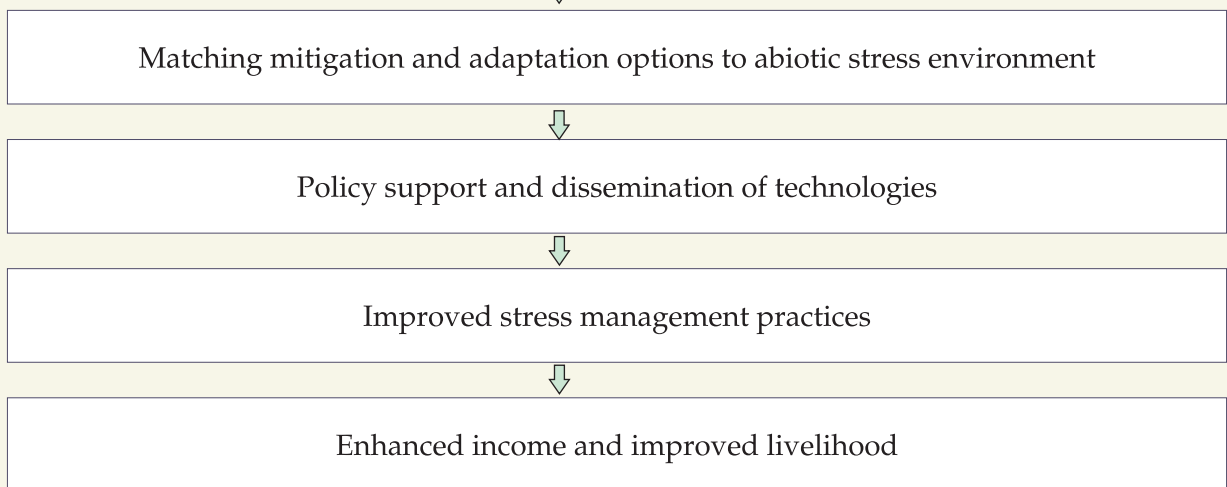
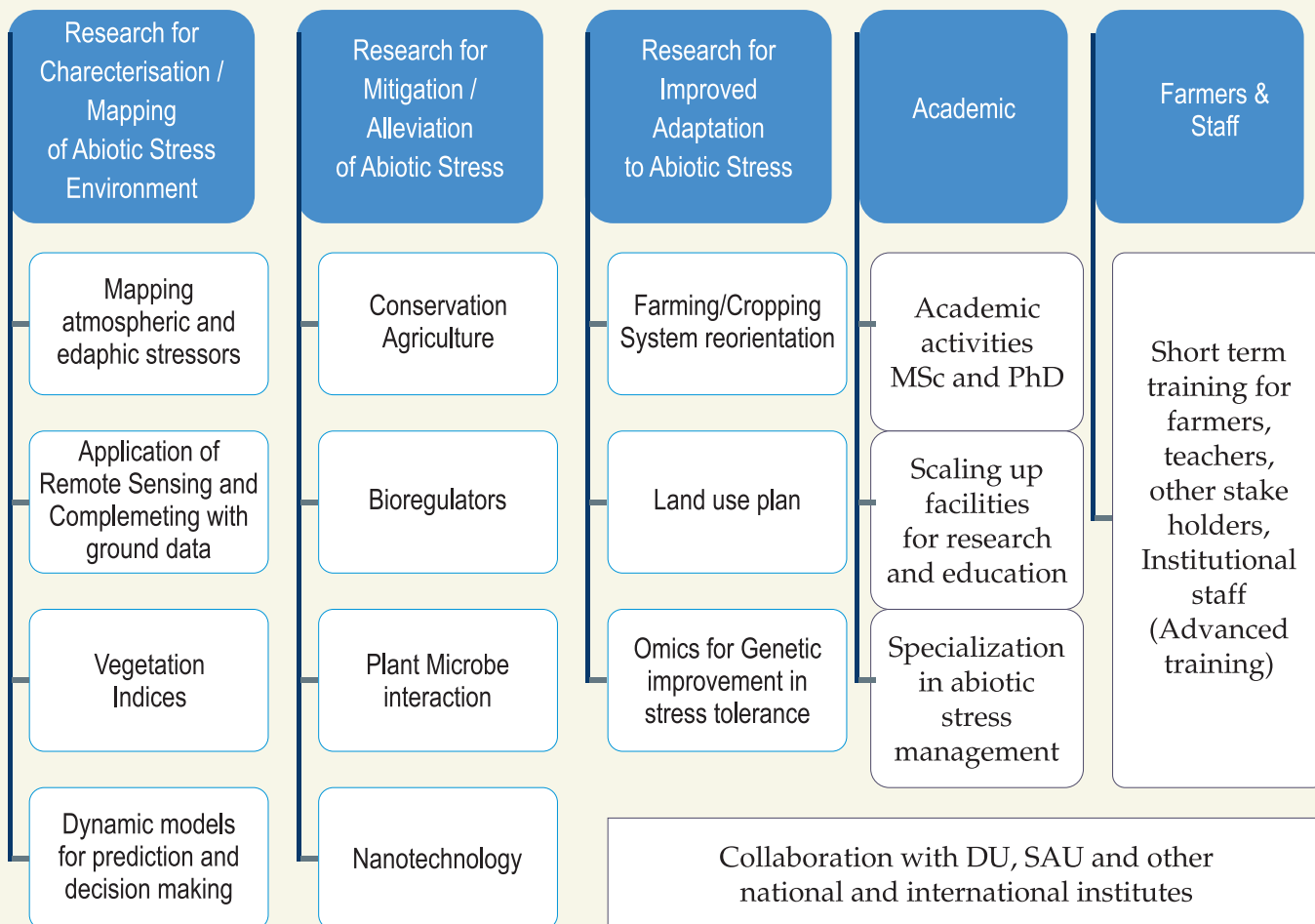


# Road Map for Future Research and Education

## Abiotic Stress Management in Agriculture

### Research to bridge knowledge and technological gap

### Capacity building



## Experts at a glance



**Dr. P. S. Minhas**, Emeritus Scientist, ICAR-CSSRI and Ex-Director of ICAR-NIASM. Earlier he served as Project Coordinator, AICRP-SSW at Central Soil Salinity Research Institute, Karnal and ADG (IWM), ICAR, New Delhi; Director of Research, Punjab Agricultural University, Ludhiana ; ADG (Soil & Water Management), Indian Council of Agricultural Research, New Delhi, 2010-12. He has been awarded Rafi Ahmed Kidwai Award (2007-08).



**Dr. A. D. Pathak**, Director, ICAR-Indian Institute of Sugarcane Research, Lucknow, developed sugarcane varieties for different agro climatic zones of sub tropical India. His group is engaged on developing breeding stocks for adaptation to prolonged winter chillness, high temperature and ratoonability under low temperature harvest in sugarcane for enhancing productivity. His research work is mainly focused on abiotic stress tolerance in sugarcane. He has won several awards including Life Time Achievement Award and Excellence in Science.



**Dr. Jitendra Kumar**, Director, ICAR-Directorate of Medicinal and Aromatic Plant Research, Boriavi, Anand, Gujarat, India. Dr Jitendra Kumar has made significant contribution in the area of agrochemical formulations, botanicals and Nanotechnology. He has over 350 scientific publications including 13 patents / patent applications, about 115 research papers in reputed national and international journals and 09 books.



**Dr. S. M. K. Naqvi**, Director, ICAR-Central Sheep and Wool Research Institute, Avikanagar. His major areas of research are small ruminants, reproductive biotechnology and stress physiology. He is recipient of several awards including ICAR award for Team Research (Biennium) 2003-04, 1997-98. He suggested that methods for quantification of stress need to be devised for adaptation and mitigation strategies. Behavioral studies needs to be taken up for adaptability of livestock.



**Dr. A. K. Saxena**, Director, ICAR-National Bureau of Agriculturally Important Microorganisms, Kusmaur, Mau Nath Bhanja. He has significantly contributed in the area of plant-microbe interactions and molecular diversity of bacteria. He has published about 120 research publications in reputed national and international journals. He is recipient of XIV Shri. Hari Krishna Shastri memorial award and distinguished scientist award.



**Dr. Bijendra Singh** is Director, ICAR-IIVR, Varanasi. His research is focused on vegetable breeding and Okra breeding. He has studied genetic variability and correlation analysis in okra. His group is involved in investigation on response of French bean to nutrients like phosphorus and boron.



**Dr. N. V. Patil**, Director, ICAR-National Research Centre on Camel, Bikaner. He is having more than 117 research publications in reputed national and international journals. He suggested exploiting the genetic mechanisms of camel to sustain in harsh conditions such as thermal and drought stressors for other livestock species. Impact of radiation stress in animals requires attention.



**Dr. S. D. Sawant**, Director, ICAR-National Research Centre for Grapes, Pune. Developed weather data based models to estimate risk levels of grape diseases Downy Mildew, Powdery Mildew, and Anthracnose. These models were used in online interactive system to generate plot specific day to day advisory on disease management in grapes. His team is associated with abiotic stress tolerance in grape and development of DSS.



**Dr. E. Chakurkar**, Director (A), ICAR-Central Coastal Agricultural Research Institute, Goa. He is recipient of the "Fakhruddin Ali Ahmed Award (Bianum)" on 16<sup>th</sup> July 1998 and "Fellow of National Academy of Veterinary Sciences" in 2007. He emphasised that the breeds adapted to coastal conditions such as Konkan Kanyal goat and Shwet Kapila cattle need to be studied for their adaptation to scarcity zones.



**Dr. V. K. Mishra**, Head, Central Soil Salinity Research Institute, Regional Research Station, Lucknow is renowned for his contribution in the area of abiotic stress management in saline and sodic environments. He has also significantly contributed for economic micro-rainwater harvesting for rural hill farmers. He also has expertise in soil health management and soil nutrient management. He has authored number of high impact publications in various prestigious journals.



**Dr. K. N. Agrawal**, Project Coordinator is well known in the area of precision farming, agricultural engineering, ergonomics and farm mechanisation. His work on anthropometric considerations of farm tools design for tribal workers of north-east regions of India is well recognised. He has developed different tools and techniques for efficient farming practices in different regions of India. He has published several research papers in reputed journals.



**Dr. K. K. Sharma**, Principal Scientist, ICAR-Indian Institute of Millets Research, Hyderabad, His research is focused on etiology and epidemiology of important diseases of rabi sorghum with emphasis on root and stalk rots and their Integrated management. Evaluation of sorghum and foxtail millet germplasm/varieties/hybrids for resistance to important diseases and insect-pests. He is now associated with Screening Sorghum germ plasm for abiotic stresses.



**Dr. K. N. Bhilegaonkar**, Principal Scientist, Incharge ICAR- IVRI, TEC, Pune, He has published about 110 research papers in reputed journals. He emphasized that collaborative research should be carried to study abiotic stressors on livestock in cattles. He suggested that research needs to be carried out on impact of abiotic stressors on prevalence of various livestock diseases under changing climate scenario.



**Dr. U. Rajkumar**, Principal Scientist, ICAR-Directorate of Poultry Research, Hyderabad. His research is a focused on molecular characterization of chicken and marker-trait associate studies with growth and improvement of rural poultry germplasm for backyard poultry. He emphasized the need to study genetic potential of indigenous poultry breeds such Kadaknath, red jungle fowl etc. for adaptation to abiotic stressors.



**Dr. H. S. Talwar**, Principal Scientist, ICAR-Indian Institute of Millet Research, Hyderabad. His research is focused on climate change and abiotic stresses management in post-rainy sorghum, understanding physiological basis of drought tolerance in Finger and Foxtail millets. His major contributions involved identification of genetic stocks with improved drought tolerance in Rabi sorghum, salinity terant genetic stock identification in sorghum and understanding mechanisms of drought and salinity tolerance in sorghum.



**Dr. Ratan Tiwari**, Principal Scientist (Biotechnology), ICAR-Indian Institute of Wheat & Barley Research, Karnal. His research is focused on biotechnological advances in wheat for evaluating traits associated with drought and heat stress tolerance. He use the precision phenotyping at IIWBR, for screening diverse wheat genotypes including released variety, elite lines, synthetic hexaploids for identification of drought tolerant genotypes based on root traits phenotyping.



**Dr. P. S. Basu**, Principal Scientist, ICAR-Indian Institute of Pulses Research, Kanpur. He has developed pigeon pea and chickpea donors for high yield. His group has been successful in identification of drought tolerant pigeon pea and chickpea by phenotyping root traits, thermal imaging and chlorophyll fluorescence. He has published research papers in peer reviewed journals. He has generated information on drought and heat stress on pigeon pea, chick pea, lentil, lathyrus and arid legumes. He opines trait based screening for tolerance to these stresses.



**Dr. G. P. Obi Reddy**, Pr. Scientist, Division of Remote Sensing Applications, National Bureau of Soil Survey & Land Use Planning, Nagpur. He is specialized in Geoinformatics, remote sensing and GIS applications and he is working in the fields of applied geomorphology, soil-landscape modeling, land resource inventory, land use/land cover studies, design and development of Soil Information Systems in GIS. He has published 70 peer reviewed research papers in national and international journals of repute. He is recipient of Indian National Geospatial

Award-2007 and Geospatial Award for Excellence-2013.



**Dr. S. D. Ramteke** is Principal Scientist, National Research Centre for Grapes. His research is focused on Plant growth hormones and their management in grapes, Abiotic stress management, Weed management, Physiological disorders and their control. His group is involved in developing the protocol/standardization of plant hormones for promising varieties, physiological disorders and their management and residue studies.



**Dr. Anuradha Upadhyay** is Principal Scientist at ICAR-National Research Centre for Grapes. Her area of research is focused on Functional genomics and SNP analysis of abiotic stress in grapevine and functional analysis of salinity stress and in silico identification of salinity stress responsive transcription factors and their Cis-regulatory elements in grape.



**Dr. Rahul Tripathi** has expertise in the area of Soil Science, Soil Physics, Soil & water conservation, Remote Sensing, GIS, Crop Modelling. He has significantly contributed for the development of various technologies for N management in rice, validation of MODIS LAI product over Trans Gangetic Plains of India, prediction of crop biophysical parameters using Inversion of Radiative Transfer Model for Precision farming, vegetation health index, improvement of soil physical condition, etc. He has also authored number of publications in prestigious journals.



**Dr. Ashis Maity** is well known for his expertise in soil science. He has significantly contributed in the area of microbe mediated plant growth promotion, which includes Inoculation of *Penicillium pinophilum* with potassium feldspar for improvement in plant growth, photosynthetic activity, chlorophyll content, availability of soil K and P and their uptake. He is editor of the International Journal of Bio-resource and Stress Management. He has authored different high impact publications in the area of plant microbe interactions.



**Dr. Sohanvir Singh**, Nodal Officer NICRA, ICAR- NDRI, Karnal. His research areas are environmental and work physiology climate change reproduction. He emphasized requirement of developing thermal indices and thermoneutral zones for different indigenous livestock and suggested collaborative studies on this aspect.



**Dr. K. Dhinesh Babu**, is Principal Scientist at ICAR-National Research Centre on Pomegranate. His research area is focused on genetic improvement of pomegranate for yield, quality and resistance to biotic stress through conventional breeding and biotechnological approaches. He has published several research papers in reputed national and international journals.

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# Meeting: Schedule

## Management of Abiotic Stress in Agriculture: Roadmap for Future Research and Education

(January 30-31, 2017)

### 30-01-2017 (Monday)

10.00 to 10.30 **Registration**

10.30 to 11.30 **Inaugural session**

#### **Venue: Auditorium**

Chairman : Dr. P.S. Minhas, Emeritus Scientist, ICAR-CSSRI, Karnal &  
Ex-Director, ICAR-NIASM

Co-Chairman : Prof. Narendra Pratap Singh, Director, ICAR-NIASM, Baramati

Rapporteur : Dr. Jagadish Rane, Head, SDSM, ICAR-NIASM, Baramati

Welcome & Introductory Remark by Prof. Narendra Pratap Singh, Director, ICAR-NIASM

Remarks of Chairman and Co-Chairman

11.30 to 12.00 **High Tea**

12.00 to 03.30 **Session I: Natural Resource Management (NRM)**

#### **Venue: Conference Room No 2**

Introductory Remarks

Chairman : Dr. P.S. Minhas, Emeritus Scientist, ICAR-CSSRI, Karnal &  
Ex-Director, ICAR-NIASM

Co-Chairman : Prof. Narendra Pratap Singh, Director, ICAR-NIASM, Baramati

Rapporteur 1 : Dr. K. K. Krishnani, ICAR-NIASM, Baramati

Rapporteur 2 : Dr. K. K. Meena, ICAR-NIASM, Baramati

#### **Presentations by institutes**

1. Dr. A.K. Saxena Director, ICAR-NBAIM, Mau Nath Bhanjan
2. Dr. V. K. Mishra, Head, ICAR, CSSRI, Lucknow
3. Dr. P. R Ojasvi, Head, ICAR-IISWC, Dehradun
4. Dr. Badre Alam, Pr. Scientist, ICAR-CARI, Jhansi
5. Dr. G. P. Obi Reddy, Pr. Scientist, ICAR, NBSSLUP, Nagpur
6. Dr. K. N. Agrawal, Senior Scientist, ICAR-CIAE, Bhopal
7. Dr. U. K. Maurya, Senior Scientist, ICAR-IISWC, Dehradun
8. Dr. Ashis Maity, Scientist, ICAR-NRCP, Solapur

Discussion and Recommendations

01.30 **Lunch Break**

**30-01-2017 (Monday)**

12.00 to 03.30 Session II : Crop Improvement and Horticultural Sciences

Venue: Conference Room No 1

**A. Crop Improvement**

Chairman : Dr. A.D. Pathak, Director, ICAR-IISR, Lucknow

Co-Chairman : Dr. H.S. Talwar, Pr. Scientist, ICAR-IIMR, Hyderabad

Rapporteur 1 : Dr. D. P. Patel, Pr. Scientist, ICAR-NIASM, Baramati

Rapporteur 2 : Dr. Ajay Kumar Singh, Sr. Scientist, ICAR-NIASM, Baramati

**Presentations by institutes**

1. Dr. Ratan Tiwari, Pr. Scientist, ICAR-IIWBR, Karnal
2. Dr. A. D. Pathak, Director, ICAR-IISR, Lucknow
3. Dr. P. S. Basu, Pr. Scientist, ICAR-IIPR, Kanpur
4. Dr. G. K. Satpute, Sr. Scientist, ICAR-IISR, Indore
5. Dr. Krishanppa R, Scientist, ICAR-RCNEH, Barapani
6. Dr. H. S. Talwar, Pr. Scientist, ICAR, IIMR, Hyderabad

**Participants**

1. Dr. Mamrutha, Scientist, ICAR-IIWBR, Karnal
2. Dr. Ganapati, Pr. Scientist, ICAR-IIMR, Hyderabad
3. Dr. K.K. Sharma, Pr. Scientist, ICAR-IIMR, Hyderabad, RS. Sholapur
4. Dr. Mahesh Kumar, Scientist, ICAR-NIASM, Baramati
5. Dr. Prashantkumar S Hanjagi, Scientist, ICAR-NIASM, Baramati
6. Dr. Ramteke, Pr. Scientist, ICAR-NRCG, Pune

03.30 High Tea

03.45 to 06.30 **B. Horticulture Science**

Chairman : Dr. Bijendra Singh, Director, ICAR-IIVR, Varanasi

Co-Chairman : Dr. Jitender Kumar, Director ICAR-DMAPR, Anand

Rapporteur-1 : Dr. S. K. Bal, Pr. Scientist, ICAR-NIASM, Baramati

Rapporteur-2 : Dr. Yogeshwar Singh, Sr. Scientist, ICAR-NIASM, Baramati

**Presentations by institutes**

1. Dr. Yogeshwar Singh, Sr. Scientist, ICAR-NIASM, Baramati
2. Dr. Jitendra Kumar, Director, ICAR-DMAPR, Anand, Gujarat
3. Dr. S. Rajan, Director, ICAR-CISH, Lucknow
4. Dr. Bijendra Singh, Director, ICAR-IIVR, Varanasi
5. Dr. B. D. Sharma, Head and Pr. Scientist, ICAR-CIAH, Bikaner
6. Dr. Pranjali H. Ghodkhe, Scientist, ICAR-DOGR, Pune

7. Dr. A. Thangasamy, Scientist, ICAR-DOGR, Pune
8. Dr. S. S. Sawant, Director, ICAR-NRCG, Pune
9. Dr. Anuradha Upadhyay, ICAR-NRCG, Pune
10. Dr. K. Dinesh Babu, ICAR-NRCP, Solapur

Discussion and Recommendations

**01.30 Lunch Break**

**30-01-2017 (Monday)**

12.00 to 03.30 Session III: Animal and Fisheries Sciences

Venue: Committee Room

Chairman : Dr. S. M. K. Naqvi, Director, ICAR-CSWRI, Avikanagar (Raj.)

Co-Chair : Dr. N. V. Patil, Director, ICAR-NRCC, Bikaner

Rapporteur 1 : Dr. N. P. Kurade

Rapporteur 2 : Dr. M. P. Brahmane

**Presentations by institutes**

1. Dr. E. B. Chakurkar, Director (A), ICAR-CCARI, Goa
2. Dr. Sohanvir Singh, Nodal Officer-NICRA, ICAR-NDRI, Karnal
3. Dr. K. N. Bhilegaonkar, Pr. Scientist & SIC, Regional Station, ICAR-IVRI, Pune
4. Dr. Subodh Gupta, Pr. Scientist, ICAR-CIFE, Mumbai
5. Dr. U. Rajkumar, Pr. Scientist, ICAR-DPR, Hyderabad
6. Dr. V. R. Suresh, Head & Pr. Scientist, ICAR-CIFRI
7. Dr. Hirak Kumar Barman, Pr. Scientist, ICAR-CIFA, Bhubaneswar
8. Dr. Tanveer Husain, Scientist, ICAR-CIBA, Chennai
9. Dr. Ratheesh Kumar R, Scientist, ICAR-CIMFRI, RS, Mumbai

**01.30 Lunch Break**

31-01-2017 (Tuesday)

10.00 to 11.30 Plenary session

Venue: Conference Room No 1

Chairman : Dr. P. S. Minhas

Co-Chairman : Prof. Narendra Pratap Singh

Rapporteur-1 : Dr. K. K. Krishnani, Head & Pr. Scientist, ICAR-NIASM

Rapporteur-2 : Dr. S. K. Bal, Pr. Scientist, ICAR-NIASM

Participants : Scientists from all the session

Discussion on academic activities

11.30

High Tea

11.45

Recommendations of all sessions

1. Natural Resource Management
2. Crop Science
3. Horticulture Science
4. Animal Science
5. Fisheries Science

Remarks of Chairman and Co-Chairman

Director's remarks

Vote of Thanks by Dr. Jagadish Rane

01.30

Lunch Break

02.30

Visit to Laboratory and Field

