taas
Progress Through Science

Building Trust:

The Journey of TAAS

2001-2015

The Journey by TAAS in National Perspective

The Hon'ble Former Prime Minister, Shri Atal Bihari Vajpayee had coined the famous slogan *"Jai Vigyan"* in 1998 to underline the importance of knowledge in India's progress, and to expand/complement the existing popular slogan *"Jai Javan, Jai Kisan"* given by the Hon'ble Former Prime Minister, Shri Lal Bahadur Shastri. Following this slogan, Government of India launched 20 National Jai Vigyan Missions in various fields of science. Two of the successful ones among these were from agriculture sector, covering food and nutritional security, and plant genetic resources, which got high priority approval and were steered by the Indian Council of Agricultural Research. With this momentum and push from the leadership, these two mission mode projects in agriculture had already entered the implementation phase when the 88th ISC was held in January 2001. The Trust for Advancement of Agricultural Sciences (TAAS) was established with the efforts of Dr. R.S. Paroda, General President of the 88th Indian Science Congress to provide a Think Tank on issues of national importance, particularly food, nutrition and environmental security, as a follow up of the recommendations emerged. The TAAS has organized a series of activities; come out with important policy recommendations, and catalyzed to push the scientific agenda for addressing malnutrition, food security and issues of environmental safeguards in the development of genetically modified crops, thus paying gratitude to Bharat Ratna, Shri Atal Bihari Vajpayee, the Hon'ble Former Prime Minister of India. TAAS envisages to strengthen and intensify its need based policy back-up activities in the interest of agriculture, farmers and the nation.

TAAS Networking in an International Perspective

After Rio+20, there is now renewed emphasis on agricultural research and innovation for development (ARI4D). Also the global leaders have rightly recognized the importance of agriculture sector in addressing effectively the sustainable development goals (SDGs), especially to address the concerns of hunger, malnutrition and sustainability of available natural resources. In this context, TAAS from the very beginning has been working to address the concerns of food, nutrition and environmental security by establishing national, regional and international partnerships to catalyze the processes of policy advocacy and public awareness. In this context, a number of dialogues have already been organized during the last 15 years on thematic issues of considerable relevance to its stakeholders. This publication is an account of all such initiatives taken in partnership mode by TAAS.

Building Trust:

The Journey of TAAS

(2001-2015)

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Dr. R.S. Paroda

General President, 88th Session of Indian Science Congress
& Founder Chairman TAAS till date

Foreword

The Trust for Advancement of Agricultural Sciences (TAAS) was formed as a consequence of a vision statement made by the then Hon'ble Prime Minister, Shri Atal Bihari Vajpai while inaugurating the 88th Session of the Indian Science Congress in 2001. He had exhorted the scientists to interact with people to create required scientific temper in the society so as to stimulate a positive change towards faster agricultural growth. In order to achieve this objective, an idea was conceived to form a neutral platform to provide much needed interface among agricultural scientists-stakeholders-policy makers. Thus, the Trust for Advancement of Agricultural Sciences (TAAS) was established with the active support of its founder Vice-President Dr. Anupam Varma, Secretary Dr. N.N. Singh and members, especially Dr. S. Nagarajan and Dr. Narendra Gupta.

The primary objective of TAAS is to act as a think tank to deliberate on thematic issues relating to agricultural research and innovation for development and catalyze the policy makers for implementation of important recommendations. To achieve these objectives, TAAS has been organizing brainstorming sessions/symposia/seminars/lectures by eminent scientists, and conferring awards on eminent scientists in recognition of their outstanding contributions in the field of agriculture research for development.

TAAS has so far organized 24 interactive meetings on diverse important topics in the form of symposia/seminars, 12 lectures of eminent speakers, and brought out 9 strategy papers on issues of high national interest, including 2 strategy lectures on seed sector. In rest part of the current year, 2015, three similar activities are already in the pipeline. The recommendations emerging out of these initiatives have sensitized the scientists, and policy makers towards diversification of agriculture to improve both productivity and profitability, and created awareness among farmers to judiciously use the scarce natural resources such as land and water. I appreciate and acknowledge the contributions of all colleagues and friends from the TAAS family, India and abroad who have participated and contributed towards making the journey by TAAS productive and fruitful.

TAAS has also brought out more than 40 other publications to stimulate strengthening of agricultural science base and thereby catalyse inclusive growth and development to a greater extent. These have been well received by the researchers, policy makers, students and other stakeholders.

While TAAS continues to work towards achieving its main objectives, it is currently striving hard to diversify its activities to cover untapped areas, with greater emphasis on out-scaling innovation for impact on smallholder farmers. This publication provides a comprehensive account of various achievements of TAAS during the last fifteen years of its existence. I do hope that the readers will find this publication both useful and rewarding.

R.S. Paroda,
Chairman, TAAS

Acknowledgements

Trust for Advancement of Agricultural Sciences (TAAS) owes its establishment to the vision of Padma Bhushan Dr. R.S. Paroda, former Director General, Indian Council of Agricultural Research (ICAR) and Secretary, Department of Agricultural Research and Education (DARE) and the General President of the 88th Session of the Indian Science Congress held in January, 2001 at the Indian Agricultural Research Institute (IARI) Campus, New Delhi. He conceptualized the idea, and established a platform to link science with society through a Think Tank process for deliberating on important national issues relating to agricultural research for innovation and development, and in the process to sensitize the policy makers. The impact made by TAAS on different policy making agencies is a testimony of the dynamic leadership provided by Dr. Paroda, and the able Trustees of TAAS.

Establishment of TAAS was made possible mainly due to support of Dr. S. Nagarajan, former Director, IARI who provided an office space on the campus of prestigious and popular 'Pusa Institute' in December, 2002. Successively, the other two Directors, Dr. S.A. Patil and Dr. H.S. Gupta, also extended their full support to TAAS and its activities which is highly appreciated.

Dr. S. Ayyappan, Director General, ICAR and the Secretary, DARE has been closely associated with TAAS as a trustee. TAAS gratefully acknowledges his support.

Some corporate houses and organizations like Mahyco Foundation, Sehgal Foundation, Venkateshwara Hatcheries, Monsanto, Nuziveedu Seeds Pvt. Ltd., National Seed Association of India (NSAI), Rasi Seeds, Asia-Pacific Association of Agricultural Research Institutions (APAARI), National Academy of Agricultural Sciences (NAAS), and a few State Agricultural Universities have provided their support to TAAS activities, which is duly acknowledged. Mahyco's continued support for the prestigious Dr. M.S. Swaminathan Award since its inception is very much appreciated.

Last but not the least, valuable help provided by late Dr. R.K. Arora and current Vice-Chairman Dr. P.L. Gautam is highly appreciated. This

compilation summarizing the highlights of fifteen Years of TAAS has been possible mainly with the sincere efforts and dedicated support by Dr. Narendra Gupta to me which is duly acknowledged. Support of Dr. Bhag Mal, Dr. J.L. Karihaloo and Dr. Sudhir Kochhar for reviewing the manuscript and Ms. Simmi Dogra in providing the secretarial assistance is very much appreciated and acknowledged.

N.N. Singh
Secretary, TAAS

Acronyms and Abbreviations

APAARI	Asia-Pacific Association of Agricultural Research Institutions
APCoAB	Asia-Pacific Consortium on Agricultural Biotechnology
APMC	Agricultural Produce Marketing Committee
AR4D	Agricultural Research for Development
ARI	Agricultural Research Institutions
ATIC	Agricultural Technology Information Centre
ATMA	Agricultural Technology Management Agency
AVRDC	Asian Vegetable Research and Development Centre
BAR	Bureau of Agricultural Research
BCM	Billion Cubic Meter
BRAI	Biotechnology Regulatory Authority of India
CBD	Convention on Biological Diversity
CDRI	Central Drug Research Institute
CGIAR	Consultative Group on International Agricultural Research
CH_4	Methane
CIAE	Central Institute of Agricultural Engineering
CIMMYT	International Maize and Wheat Improvement Center
CM	Cubic Meter
CO_2	Carbon Dioxide
CSO	Civil Society Organization
CWANA	Central and West Asia, and North Africa
DARE	Department of Agricultural Research and Education
DBT	Department of Biotechnology
DAC	Department of Agriculture and Cooperation
DST	Department of Science and Technology
DUs	Deemed Universities
EDP	Executive Development Programme
EPA	Environmental Protection Agency

FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FDI	Foreign Direct Investment
FSSAI	Food Safety Standards Authority of India
GAP	Gender in Agricultural Partnership
GCARD	Global Conference on Agricultural Research for Development
GCWA	Global Conference on Women in Agriculture
GDP	Gross Domestic Product
GFAR	Global Forum on Agricultural Research
GHGs	Green House Gases
GI	Geographical Indications
GIS	Geographical Information System
GM	Genetic Modification/Genetically Modified
GMO	Genetically Modified Organism
HRD	Human Resource Development
HYV	High Yielding Variety
IARC	International Agricultural Research Centre
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistical Research Institute
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agriculture Research in the Dry Areas
ICDS	International Child Development Scheme
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information Communication Technology
IFAD	International Fund for Agricultural Development
IFFCO	Indian Farmers Fertilizer Co-operative
IIHR	Indian Institute of Horticultural Research
IIT	Indian Institute of Technology
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
IMOD	Inclusive Market Oriented Development
IPR	Intellectual Property Right(s)
IRRI	International Rice Research Institute
ISPRD	Indian Society of Pulses Research and Development

ITDS	International Technology Dissemination System
ITK	Indigenous Technical Knowledge
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IVLP	Institute Village Linkage Program
IVRI	Indian Veterinary Research Institute
JIRCAS	Japan International Center for Agriculture Sciences
KRIBHCO	Krishak Bharat Cooperative
KT	Knowledge Transfer
KVK	Krishi Vigyan Kendra
LFM	Linking Farmers to Market
LLRUVAS	Lala Lajpat Rai University of Veterinary and Animal Sciences
MANAGE	National Institute of Agricultural Extension Management
MDG	Millennium Development Goals
MDP	Management Development Programme
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MSP	Minimum Support Price
N_2O	Nitrous Oxide
NAARM	National Academy of Agricultural Research Management
NAIS	National Agricultural Information System
NAAS	National Academy of Agricultural Sciences
NARS	National Agricultural Research System
NASF	National Agricultural Science Fund
NBA	National Biodiversity Authority
NBPGR	National Bureau of Plant Genetic Resources
NDDB	National Dairy Development Board
NFSM	National Food Security Mission
NGO	Non-Governmental Organization
NIC	National Informatics Centre
NICRA	National Innovations on Climate Resilient Agriculture
NIF	National Innovation Fund
NIN	National Institute of Nutrition
NRAA	National Rainfed Area Authority
NRCPB	National Research Center for Plant Biotechnology
NSAI	National Seed Association of India

OPV	Open Pollinated Variety
OSU	Ohio State University
PAU	Punjab Agricultural University
PCAARRD	Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development
PDS	Public Distribution System
PHT	Post-Harvest Technology
PPP	Public-Private Partnership
PPV&FRA	Protection of Plant Varieties & Farmers' Rights Authority
QPM	Quality Protein Maize
R&D	Research and Development
RAAI	Rainfed Area Authority of India
RAC	Research Advisory Committee
RDNA	Recombinant DNA
RKVY	Rashtriya Krishi Vikas Yojana
RRS	Regional Research Station
SAU	State Agricultural University
SDA	State Department of Agriculture
SDAH	State Department of Animal Husbandry
SHG	Self-Help Group
SMTA	Standard Material Transfer Agreement
SOC	Soil Organic Carbon
SRC	Staff Research Council
SRR	Seed Replacement Rate
TM	Trade Mark
TMOP	Technology Mission on Oilseeds and Pulses
USAID	United States Agency for International Development
UPOV	International Union for Protection of New Varieties of Plants
VCU	Value for Cultivation and Use

1 Genesis of TAAS

Background

Trust for Advancement of Agricultural Sciences (TAAS) is a non-profit organization formed in response to a vision statement (Annexure-1) prepared jointly by all the Science Academies of India and released by the then Hon'ble Prime Minister, Shri Atal Bihari Vajpai while inaugurating the 88th Session of the Indian Science Congress (88th ISC) at IARI, New Delhi on January 3, 2001. He had observed in his inaugural speech that science and technology will perhaps be the most potent among the many forces that will shape human history in the new millennium. He exclaimed that "Our goal to make India a leading nation in the world in the new century hinges critically on how successfully we take science to the people and create a strong scientific temper in our society".

The 88th ISC left a deep impression of the Indian leadership on all generations of Indian scientists and the budding scholars pursuing various streams of science as they turned past the millennium. They also realized the importance of food, nutrition and environmental security. This was a good beginning but much more was required to be done in agriculture sector as a follow up. Dr. R.S. Paroda, General President of the 88th session while reviewing the details of this overwhelming success with the National Organizing Committee also brought out two critical follow up points to their attention. First, the agricultural sciences need further systematic nurturing and promotion through research to contribute to sustainable economic development. Second, the 88th ISC should not be concluded as a singular event but

Hon'ble Prime Minister, Shri Atal Bihari Vajpai Inaugurating 88th Session of Indian Science Congress, 2001

Release of Vision Document by Hon'ble Prime Minister

it should be a beginning of a new movement of harnessing science, particularly agricultural sciences, for the welfare of people and the national economy. The idea was spontaneous but capable of writing a new chapter to drive scientific pursuits for development in farm sector.

Eventually, Dr. R.S. Paroda built a consensus and decided to form a Trust by the name of "Trust for Advancement of Agricultural Sciences" (TAAS), dedicated to the cause of agriculture, farmers, enterprises/industry and humanity. The Trust was formally registered vide document No. 4700, in Book No. IV, Volume No. 3075 on pages 23 to 30 on 17.10.2002 in the office of the Sub-Registrar, Sub-Distt. No. III, New Delhi with its Headquarters at the Indian Agricultural Research Institute (IARI), New Delhi.

Genesis

The Indian Science Congress Association (Established in 1814) has been into the service to the nation to advance and promote the cause of science in India for more than a century now. The 88th Session of the Indian Science Congress was held in New Delhi from 3-6 January 2001. It was organized on the campus of country's premier national institute, the Indian Agricultural Research Institute (IARI), New Delhi. Dr. R.S. Paroda, the then Secretary, Department of Agricultural Research and Education (DARE), Government of India and Director General, Indian Council of Agricultural Research (ICAR) was elected as the General President for this session, and he had been actively leading the preparations as President Elect since the conclusion of the 87th session held in January 2000. The 88th Session of ISC being the first one of the new millennium, and keeping in view the United Nations Millennium Development Goals (MDGs) proclaimed in 2000, the theme of the science congress was specially chosen to address: "Food, Nutrition and Environmental Security".

Agriculture is the source of perpetual creations on which civilization depends. The Millennium Summit of the United Nations in 2000 had adopted the United

Nations Millennium Declaration and established eight international development goals, commonly known as the Millennium Development Goals. The world had already recognized the importance of sustainable development at the Earth Summit in 1992 and then set these MDGs in various sectors at the turn of the century; to be achieved by 2015. Thus, the role of agricultural sciences became even more prominent as they were poised to make potential contribution to the eradication of extreme poverty and hunger, provide nutrition to improve maternal and child health, and contribute to ensuring environmental sustainability.

The inaugural speech (Annexure 1) by the then Hon'ble Prime Minister, Shri Atal Bihari Vajpayee was full of motivation. He exclaimed, "Of the many forces that will shape human history in the new millennium, science and technology will perhaps be the most potent. We know how science and technology have changed the complexion of the world in the last couple of centuries of the last millennium. But this is just the beginning of a long and exciting voyage. All the discoveries of science and all the inventions of technology so far amount to the arrival of just a couple of stars in a sky of countless stars that are yet to appear.

On thematic area of the 88th ISC, the Hon'ble Prime Minister observed, "Having achieved food sufficiency, our aim now is to achieve food security for all our citizens. The percentage of our population living below the poverty line has come down, and we have overcome starvation. Our objective now is to overcome malnutrition. The new century will be the Century of Knowledge and the Century of Mind. However, if the brain does not develop properly in nearly one-third of our children who are undernourished, how will we be able to create those young minds that are essential to build India of our dreams in the 21st century? More than 50 percent of the pregnant women and children are anemic. Vitamin and protein deficiencies are rampant. These realities overshadow our achievements and burden our national conscience. … I urge the participating scientists to come up with comprehensive and useful recommendations to deal effectively with all the issues relating to food, nutrition, and environmental security. Accomplishing this task requires massive efforts in many areas. ..."

During the inaugural function, the Hon'ble Prime Minister also released an important Vision Statement (Annexure 2) brought out jointly by all the National Scientific Academies. It stated:

"…By 2020, India will be free of poverty, hunger and malnutrition, and become an environmentally safe country. This, we believe, will be possible to achieve through accelerated social and economic development by harnessing the advances in science, and blending them with our indigenous knowledge, wisdom and unique socio-cultural ethos. We believe India can banish poverty and emerge as a developed nation by promoting growth through efficient and sustainable use of our human, natural and other resources…"

The Vision Statement concluded by stating:

"Hunger free India is an idea whose time has come. Let us launch a science-based crusade for the elimination of hidden hunger and malnutrition".

The 88th ISC came out with a series of recommendations and way forward (Annexure 3) to give a fresh impetus for actions aimed at sustainable development as well as nutritional and food security. Government of India, Ministry of Agriculture has a separate department to administer the activities related to agricultural research and education, and the country has an elaborate national agricultural research system comprising of ICAR institutions and state agricultural universities. Many professional societies and the academy of agricultural sciences provide supplementary scientific and academic back-ups. Some NGO and private sector led R&D establishments are also prominent besides many international agricultural research centres having their regional or country offices in India. They perform their mandate based activities. A new realization came with the 88th ISC that much more was needed to be done to carry out the Hon'ble Prime Minister's 'agricultural science based crusade for the elimination of hidden hunger and malnutrition'. A High Level Think Tank could have been a relevant complementary mechanism to assess, deliberate and recommend researchable and policy issues of highest esteem.

In view of this, TAAS got established to act as a 'Think Tank' to deliberate on thematic issues of national importance and provide a neutral platform to all stakeholders associated with agricultural research for development (AR4D) in India. Significant events pertaining to the establishment of TAAS are given in the Box 1.

Box 1: Dates and Events leading to establishment of TAAS

- 3 January 2001 — Inaugural speech by the Hon'ble Prime Minister in the 88th ISC stressing the need for creating scientific temper and reaching the society
- 7 January 2001 — Decision to form a Trust under the Chairmanship of Dr. R.S. Paroda, General President of the Indian Science Congress
- 24 August 2002 — First Meeting of TAAS Trustees
- 17 October 2002 — Registration of the Trust as TAAS
- 14 December 2002 — Opening of TAAS office on IARI Campus

Inauguration of TAAS office

2 Goal, Mission, Objectives and Governance of TAAS

Goal

- To ensure an accelerated movement for harnessing agricultural science for the welfare of people.

Mission

- To promote growth and advancement of agriculture through scientific interactions and partnerships.

Objectives

- To act as a Think Tank to deliberate on key issues relating to agricultural research for development (AR4D) and influence policy decisions.
- Organizing workshops, conferences, brainstorming sessions, seminars and special lectures on emerging issues and new developments in agricultural sciences.
- To disseminate knowledge among stakeholders through publication of proceedings and policy papers.
- Instituting national awards for the outstanding contributions to Indian agriculture by the scientists of Indian and foreign origin
- Facilitating the scientific initiatives of and building partnerships with Non-Resident Indian agricultural scientists on short visits to India.

Governance of TAAS

The activities of TAAS are managed by a Board of Trustees comprising: Chairman, Vice-Chairman, Secretary, Treasurer and eight member Trustees. New members are periodically inducted in place of outgoing Trustees. The Board meets once in every quarter, reviews progress of activities and formulates future programs depending upon the prevailing needs of the society. The Board also identifies the collaborating organizations to be involved in implementing its programs/activities. The finances of the Trust are audited annually by an authorized auditor appointed by the Board. The composition of the current Board of Trustees is given in Box 2, whereas the composition of the previous Board of Trustees since 2002 onwards is given in Annexure 4.

Box 2: Board of Trustees (2015)	
Chairman	Dr. R.S. Paroda
Vice-Chairman	Dr. P.L. Gautam
Secretary	Dr. N.N. Singh
Treasurer	Dr. P.K. Joshi
Trustees	Dr. S. Ayyappan
	Dr. Gurbachan Singh
	Dr. (Mrs.) Rita Sharma
	Dr. K.L. Chadha
	Mr. Raju Barwale
	Dr. T. Mohapatra
	Dr. A.K. Srivastava
	Dr. Narendra Gupta

3 Activities of TAAS

TAAS mobilizes various players and stakeholders, and organizes number of activities to achieve its objectives. These include the following:

i. Brainstorming Sessions/Symposia/Seminars/Workshops on topics of contemporary importance in collaboration with national, regional and international organizations.

ii. Foundation Day/ Special Lectures by the leading scientists / social workers, with established record of scientific and agro-social achievements.

iii. Bringing out publications on policy/strategy papers on thematic areas of national importance.

iv. Instituting an Award to be given annually for the excellence in agricultural science, as demonstrated by evident large scale impact on society. Known as Dr. M.S. Swaminathan Award for outstanding scientific leadership in agriculture, this award was instituted in recognition of immense service rendered by Dr. M.S. Swaminathan, a great visionary and the father of Green Revolution in India, as also acknowledged in Hon'ble Prime Minister's speech at the 88th ISC.

v. Instituting specific Awards to encourage young scientists in different fields of agricultural science.

vi. Recognition of innovative practices developed by the farmers that have led to improved farming practices/higher yields and farmers' income/resource conservation/environment protection etc.

Box 3: TAAS as A Think Tank	
Addressed Issues of National Importance	1. Genetic Resource Conservation through Use
	2. Regulatory Mechanisms for GM crops
	3. Increasing Farm Productivity
	4. Out scaling Conservation Agriculture
	5. Promoting Farmer-led Innovations
	6. Linking Farmers to Markets
	7. Promoting Public-Private Partnerships
	8. Soybean and QPM Maize for Nutritional Security
	9. Linking Research with Development
	10. Role of Women in Agriculture
	11. Promoting Agricultural Innovations and Value Chains
	12. Retaining Youth in Agriculture
	13. Building Leadership in Agriculture
	14. Agricultural Knowledge Management and sharing
	15. Managing Climate Change and Soil Health
	16. Policy Advocacy for Creating Enabling Environment for Good Agricultural Practices and Resilience in Agriculture
	17. Regional and Sub-regional Partnerships for AR4D

4 Symposia/Workshops/Brainstorming Sessions Organized

Preamble

TAAS has so far organized 24 symposia/seminars/workshops (Annexure 5) on topics of thematic importance. These meetings have been attended by subject matter specialists and other concerned stakeholders who discussed specific issues rather critically and came out with specific recommendations. Subsequently, all important recommendations have been sent to the concerned researchers, science managers and policy makers for required follow up/action. A brief account of these initiatives is given below:

1. Enabling Regulatory Mechanisms for Release of Transgenic Crops

(A Brainstorming Session: October 18, 2003)

Background:

Biotechnology offers novel ways to genetically modify crop plants with improved quality or productivity, thus ensuring better income to the resource poor farmers. The varieties of crops developed through techniques of genetic engineering are

Dr. R.S. Paroda chairing the Brainstorming Session

known as genetically modified or GM crops. As expected with any new technology, concerns have been raised about safety of the cultivation of GM crops and products derived from them. Thus, in order to keep pace with the development taking place worldwide, it is essential to evolve precise mechanisms and protocols of introducing transgenes and to assess biosafety of GM corps. The process has to be fast. To address these concerns at all levels, a neutral platform comprising all stakeholders, viz., scientists, representatives of Non-Governmental Organizations (NGOs) and policy makers is required.

A brainstorming session on Enabling Mechanisms for Release of Transgenic Crops was organized on 18 October, 2003 at IARI, Pusa Campus, New Delhi to discuss relevant issues. About 100 participants, including Drs. H.K. Jain, R.P. Sharma, Manju Sharma, from different institutions, NGOs and private sector deliberated upon issues concerning biosafety of GM crops and other related issues, and came out with following recommendations:

Recommendations:

Status on Agricultural Biotechnology in India

- India's approach for the development of transgenic crops has largely depended on individual initiatives without the formulation of a composite product-oriented, integrated approach. While this has helped the nation in the generation of competent human resources, time has come to evolve a national policy, which would promote required collaboration and coordination at different inter-institutional levels, including the ICAR institutes, State Agricultural Universities (SAUs), academic institutions and the private sector so as to ensure delivery of products to end users. Large-scale development and commercial release of transgenic crop varieties would not be possible in the absence of such collaborative approach. Hence, it is critical at this juncture to build the required partnerships.
- Development and commercial release of transgenic varieties should be attempted in two phases: (i) In the first phase, molecular biologists and biotechnologists should have the primary responsibility and play an important role. However, it would be unrealistic to believe that they can also take the responsibility for the field-testing and evaluation of newly developed transgenic varieties for biosafety and other regulatory requirements, and (ii) In the second phase, there should be much closer collaboration with scientists from relevant disciplines, including plant breeders, and also with the private sector, in order to ensure timely seed production and commercialization of transgenic varieties.
- While India has made significant progress in the field of molecular biology and biotechnology, critical gaps in R&D efforts still remain. Increased

investments and intensified efforts are, therefore, necessary at this stage to create additional research capacity in areas such as gene and promoter isolation, vector constructs, and cloning and transformation protocols relevant to important Indian crops. India must embark upon a major research program in the area of functional genomics, especially in crops of considerable economic value.

- A national facility needs to be created to assist the biotechnologists through facilitated access to agronomical and economically important genes and promoters.
- India needs to generate a critical mass of highly trained molecular biologists and biotechnologists to develop cutting edge technologies, which are becoming increasingly important. There is an urgent need to organize elaborate training programs in a number of institutions having well equipped laboratories and highly trained scientists. The training program should be of longer duration (at least 6 months), in order to develop required competence in the younger generation of scientists.

Need for Public-Private Partnership

- Mechanisms need to be developed to build a strong public-private partnership. The golden triangle of partnership between International Research Centers, ICAR institutes, SAUs, and the Private Sector can help in taking the transgenics from laboratory to the field at a much faster pace.
- Steps will have to be taken so that there is a swing from 'mistrust' to 'trust' between the public and private sector players, especially in terms of Intellectual Property Right (IPR) and benefit sharing related issues.
- Possibility of developing a consortium at the national level, of both public and private sector institutions in order to promote agricultural biotechnology needs to be explored.
- Steps should be taken to create general public awareness and appreciation towards importance of transgenics among the stakeholders.
- Economic concerns of the farmers/consumers in relation to transgenic varieties/ hybrids need to be effectively addressed.

Enabling Regulatory Framework

- There is considerable overlap in the functions of the Monitoring-cum-Evaluation Committee under the Department of Biotechnology (DBT) and the agronomic evaluation of the transgenics undertaken by the ICAR. Harmonization of these functions could considerably reduce the time required for the evaluation and release of transgenic materials and also save resources.

- There is a distinct need for 'referral laboratories/institutes' for evaluating specific aspects of biosafety of transgenics, related to the human, animal, plant health and also the environmental safety.
- Prevention of distribution of spurious seeds in the name of transgenics; establishing minimum standards and criteria for the release of transgenics, revision of the Seeds Act and Rules, procedures for litigation and dispute settlement, and speedy process of evaluation of the transgenics, are some of the major concerns in relation to the regulatory framework in India, which need to be addressed on priority for effectively reaping the benefits of biotechnology in agriculture.
- The significance of patents and other IPR in relation to the development, protection and commercialization of transgenics have to be clearly understood by the researchers/ institutions involved in this field. There are a number of intellectual property rights/patent issues related to plant regeneration, plant transformation, gene sequences, promoters, vectors and screening techniques which need to be kept in mind while commercializing the transgenics. There is a need to develop appropriate mechanisms and approaches to overcome the intellectual property barriers for the successful commercialization of transgenics developed so that farmers are able to reap the benefits of biotechnological products.
- There are several complex legal issues related to the regulatory framework for the transgenics. It appears that the framework of the Environmental Protection Agency (EPA) of USA is not the most appropriate model to deal with the biotechnology related issues in India. Hence, there is an urgent need to formulate a separate legislation that would have no overlap with other legislations. A scheme of certification and internal regulatory procedures and committees should facilitate self-regulation as far as possible. Also, a formal system of Tribunals and Adjudicatory Bodies, having legal and technical experts, would help in quick dispute settlement. The bottom line is that unless transparent regulatory framework is put in place, the growth of biotechnology would continue to be hampered.
- The need was felt to have a brainstorming session to examine the pros and cons of setting up of a 'National Authority for Biosafety/Biosecurity' in order to have congruence of biotechnology, biodiversity, biosafety and biosecurity.
- For successful utilization of biotechnology in India, it is critical to devise a clear National Biotechnology Policy, which covers the important elements of contract sociale, science-led impact and risk analysis, information empowerment and awareness, with proper R&D support.

2. Role of Science and Society towards Plant Genetic Resources Management – Emerging Issues

(A Brainstorming Session: January 7-8, 2005)

Background:

Plant genetic resources (PGR) have played an important role in agricultural development. However, changes in land use pattern, increasing population and over-exploitation of natural resources are threatening these genetic resources towards depletion to the point of extinction. Therefore, urgent measures are needed to ensure proper conservation and access to genetic resources and sharing of their benefits with farmers and communities contributing towards evolution and conservation of these resources.

Lighting of lamp during inauguration by Dr. M.S. Swaminathan

A two day brainstorming session was jointly organized by TAAS, National Academy of Agricultural Research Management (NAAS) and Indian Society of Plant Genetic Resources (ISPGR) on 7-8 January, 2005 at IARI, Pusa Campus, New Delhi to deliberate on these concerns and to see what specific role science and society can play to ensure conservation and use of the plant genetic resources. In all 80 participants representing ICAR, SAUs, Govt. Departments, representatives of Academies, NGOs, Private Sector, farmers, representatives of international centers, and media participated in the brainstorming session.

The recommendations emerged out of the deliberations are summarized below:

Recommendations:

Scientific Issues

- *Establishment of National Database on Plant Diversity:* The database on plant diversity may be integrated with corresponding data on indigenous knowledge for better decision making and help in conservation/protection of biodiversity rich areas, restoration of fragmented habitats of important species and economic prospecting. This would also facilitate in the identification of specific gaps in plant genetic resources conservation so that pointed collecting missions could be mounted on priority. This national database could also serve as a

referral point for identification of stakeholders in diversity conservation and benefit sharing programs particularly in implementing various provisions of the Protection of Plant Varieties and Farmers' Rights Act, 2001 and the Biological Diversity Act, 2002.

- *Coordinated National Program for Enhancing Germplasm Evaluation and Utilization:* The National Bureau of Plant Genetic Resources (NBPGR) alone cannot characterize/ evaluate all the germplasm. This being a priority issue, it is recommended that a special All-India Coordinated Project on Germplasm Evaluation be initiated with NBPGR providing the facilitation/coordination role. There is an urgent need for development of a national information system on crop genetic resources with integration of information on passport, evaluation, conservation status, indigenous knowledge, etc., to facilitate both protection and rational use of the germplasm.
- *Developing New Conservation Strategies:* For conservation of perennials and vegetatively propagated materials, alternative methods, such as clonal repositories, *in vitro* conservation and cryopreservation need to be examined and adopted.

Social Issues

- *In situ Conservation and Community Participation: In situ*/on-farm conservation of landraces and traditional varieties need to be strengthened in partnership with farmers and the local community. In such areas, the on-going programs of tribal welfare should also take into consideration agrobiodiversity conservation as one of the important objectives. Various civil society groups working at the grass roots level for the welfare of these communities have also to be involved for on-farm conservation and sustainable management of agrobiodiversity.
- *Awareness Generation:* The present level of literacy about various international agreements and national legislations with regard to plant genetic resources is indeed very poor even among the scientific community. There is an urgent need to educate the policy makers, planners, science managers, scientists and the general public about the implications of major developments in this field.

Policy Issues

- *Strengthening NBPGR as Nodal Organization:* India can take legitimate pride in having established a single window system for plant genetic resources through NBPGR. There is a strong need to strengthen this institution including its regional stations and also networking with crop based institutes to fulfill its mandate effectively and efficiently.
- *Germplasm Exchange:* It is imperative that Indian scientists continue acquiring new germplasm accessions in unrestricted and fair manner. The Biological

Diversity Act, 2002, which the country had enacted in the recent past, should facilitate this kind of access. The scope of the material to be designated under the multilateral system for exchange of germplasm of crops, of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), requires critical understanding in order to ensure that valuable national plant genetic resources are provided the agreed access; yet at the same time protected from patent regimes elsewhere.

- *Streamlining Policy Advisory Measures:* The issues concerning agrobiodiversity, particularly in the light of recent national and international developments, cut across the mandate of various ministries and departments. A national level Advisory Committee with representations of the concerned ministries and departments should be constituted to deliberate and provide directions for the development of national policy issues related to various aspects of agrobiodiversity.
- *Germplasm Access and Benefit Sharing:* India has enacted the Protection of Plant Varieties and Farmers' Rights Act, 2001 and Biological Diversity Act, 2002, which shall help us to protect, conserve and utilize the genetic resources in a sustainable manner. The efforts for *in situ* conservation can, however, be sustained only if accompanied by appropriate policies that provide commensurate monetary benefits as well as non-monetary incentives for individuals and communities. The proposed gene fund (under Protection of Plant Varieties and Farmers' Rights Act, 2001) and biodiversity fund (under Biological Diversity Act, 2002) could be used to provide such support to the farmers and communities.
- *Cooperation between Public and Private Sector:* There is a greater need to strengthen the laboratory and field infrastructure to undertake work relating to modem biotechnology both in ICAR/SAU system as well as in private sector.

3. Role of Information Communication Technology in Taking Scientific Knowledge/Technologies to the End Users

(A National Workshop: January 10-11, 2005)

Background:

In a fast changing global environment, and globalization of agriculture economy, agriculture in developing countries including India, has to be more dynamic by harnessing the latest technologies and emerging opportunities. It is paramount that existing concern of "digital divide" and the future role of ICT in agriculture are well understood and recognized. In this context, the Trust for Advancement of Agricultural Sciences (TAAS) along with the National Academy of Agricultural Sciences (NAAS), the Indian Society of Agricultural Statistics (ISAS), and the

Dignitaries on the Dais during Inaugural Session of the Workshop

Asia-Pacific Association of Agricultural Research Institutions (APAARI) jointly organized a National Workshop on "Role of Information Communication Technology in Taking Scientific Knowledge/Technologies to the End Users" on 10-11 January, 2005 at the Indian Agricultural Research Institute, New Delhi. Around 70 experts representing different stakeholders i.e. Public Institutions (ICAR, DOAC, NIC, DBT etc.), NGOs, Foundations, Private Sector, Farmers' Commission, International Agricultural Research Centres, etc. had deliberated on all relevant issues by which ICT can become a catalyst of change in Indian agriculture.

The brainstorming sessions centered around current status, opportunities and constraints to make ICT a point of focus for making India a developed nation through progress in agriculture sector, especially by linking producers with consumers through extension. The major recommendations were:

Recommendations:

Multi-dimensional ICT-based initiatives

- ICT based initiatives for agricultural development, including farmers' prosperity, should be multi-dimensional in nature. These should be capable of addressing problems of rural communities in a holistic manner, touching all aspects of rural life including agriculture, human/animal/plant health, education, banking, governance, entertainment, etc. This can be achieved by setting up rural knowledge centres using broad band connectivity with multi-media interactive modules in problem solving mode by synergistic deployment and engagement of various stakeholders involved.

Knowledge Intensive Products and Services

- Knowledge intensive products and services for empowerment of our farmers are urgently needed. This would require a well-coordinated system among government, public and private organizations. In this context,

Indian Council of Agricultural Research (ICAR) and the Department of Agriculture and Cooperation (DAC) under the Ministry of Agriculture can play a leading role in having a National Agricultural Information System (NAIS) established.

- Suitable mechanisms need to be developed for the creation of location specific knowledge capsules in the form of CD-ROM, Portals, Kiosks, etc. through involvement of specialized institutions.

Networking of Knowledge Dissemination Agencies

- The existing knowledge dissemination agencies in the country such as ICAR Institutes, SAUs, KVKs/ATICs, NIC, IFFCO, KRIBHCO, as well as other non-government and private sector institutions need to be networked rather than creating a new institution so that available information/knowledge is shared and transmitted freely to the end users. NAIS should work in a partnership mode using the complementary strengths of partners as the basis of subsidiary responsibilities being assigned to other partners. Affirmation of authorities for specific tasks, and contributory sharing of financial resources for the smooth implementation of joint projects should be decided jointly, and well in advance. Institutions such as Indian Agricultural Research Institutes (IARI) and Indian Agricultural Statistical Research Institute (IASRI) could jointly play the knowledge and technology coordination role under NAIS.

Capacity Building of Extension System/Functionaries in ICT

- Complexities in the second-generation agriculture would require greater role of emerging ICT tools and methods in complementing the existing extension system. This would require capacity building of extension functionaries for the transfer of knowledge without dissemination losses to the end users. At the district level, the KVKs could in future play an important role provided given specific ICT mandate with commensurate human resource.
  - Village level ICT should be the ultimate goal for easy access to required knowledge by the farming community. This could be achieved through promotion of Rural Information Clinics or Rural Internet Choupals by the enthusiastic young entrepreneurs, well trained as ICT agents by the SAUs and ICAR institutions located throughout India. For access to knowledge at the farmers' door steps, the above goal must be met.
  - There is also a need to reorient the agricultural extension curriculum so that extension workers in future are spatial and information specialists as well. The National Agricultural Research System (NARS) should be proactive in providing user-friendly, need-based and locally relevant trainings.

- There should also be an emphasis on gender equity by letting women have easy access to Knowledge Transfer (K'T), ensuring gender oriented content and the increased women participation in the application of K'T.
- There is a strong need to establish joint ventures with the Private Sector and NGOs to enrich K'T resources in terms of both hardware and software and the relevant content creation.

Agricultural Knowledge Transfer Policy

- To empower agricultural community with needed information and knowledge in the coming decade (by 2015), the Government should come out with an Agricultural K'T Policy with a Mission-oriented strategy to implement the same in a time-bound manner. Only through such commitment at the highest level, we shall be able to address the concern of "Digital Divide" and empower our farmers to be well informed and competitive.

4. Farmer-led Innovations for Increased Productivity, Value Addition and Income Generation

(A Brainstorming Session: October 17, 2005)

Background:

Farming has been the main occupation of Indians for over five millennia. Over the generations, farmers have come out with numerous innovations for meeting their food, nutrition, health, fibre, fuel wood, timer and other day-to-day needs; ensured their livelihood security and exclusive community-based socio-economics; besides farm-based monetary returns. They designed a number of need-based farm implements to increase the farming efficiency. Farmers also selected numerous varieties of crops having preferred traits, higher productivity, better cooking and/or keeping quality, etc. They also developed low cost technologies to package, store and preserve both seed for prolonged vigour and health, and farm produce for increased shelf-life and marketability. However, intellectual property rights on such innovations have often been ignored. It is necessary that we duly recognize farmers' innovations and blend their traditional

Inaugural Session in progress. Seen on the dais are (L to R) Dr. S. Nagarajan, Prof. R.B. Singh and Dr. R.S. Paroda

wisdom with scientific knowledge for ensuring sustainable agriculture. A brainstorming session was organized by TAAS at IARI, Pusa Campus, New Delhi on 17 October, 2005 where about 40 participants from Research Institutes, NGOs and farmers critically discussed these issues and came out with following recommendations:

Recommendations:

Documentations of Innovations and Traditional Knowledge

- It is essential to document innovations and traditional knowledge and disseminate them further through various organizations such as Indian Council of Agricultural Research (ICAR), National Academy of Agricultural Sciences (NAAS), Trust for Advancement of Agricultural Sciences (TAAS), National Innovation Foundation (NIF), etc. Also, regional and international organizations such as FAO, Global Forum on Agricultural Research (GFAR), APAARI could be involved to promote and popularise various successful innovations by the farmers to link them to markets for better income and livelihood opportunities.
- Innovative technologies identified in one region need to be popularized in similar eco-regions elsewhere, through publication, documentation and dissemination of "Success Stories".

Marketing Opportunities for Traditional and Value Added Innovative Products

- Involvement of research institutions is quite critical to understand and blend the traditional innovations with scientific refinements for their large scale adoption and popularization.
- Risk management with focus on market opportunities through value addition is required. Farmers need to be protected from varying and often declining prices. Export potential has to be explored and procedures streamlined in order to take full advantage of globalization of agriculture.
- Aggressive programs for training of rural youth, especially farm women for post-harvest handling and value addition of the locally available agri-products, will help in linking rural communities to markets for better income opportunities.
- Setting up of a quality testing laboratory in each region to test and certify farm products (such as organic foods, medicinal plants etc.) produced by the local entrepreneurs is an essential requirement for which Government, Private Sector and NGOs' support is critical.

Plant Based Medicinal Products

- It is necessary to develop processes for producing drugs from locally available medicinal plants especially to treat common ailments. Patenting and popularising the inventive, value added products in the market will benefit both producers

and consumers. In this context, the available valuable knowledge relating to medicinal uses of local herbal plants need to be gathered and documented through appropriate incentive and reward mechanisms developed before the traditional knowledge is lost forever or remains unacknowledged.

Agro-Forestry and Horticulture

- Concept of tree plantation as social activity has to be promoted, especially in dry, desert and hilly areas, which will help in the development of agro-forestry and horticulture in these regions and also ensure better returns for the resource poor communities, besides improvement in our environment.

Agro-Tourism

- Agro-tourism around farmers' innovative efforts would not only generate greater public awareness but would also help in revenue generation and greater community involvement in protecting our rich biodiversity.

Farmers' Innovation Promotion Board

- Creation of a "Farmers' Innovation Promotion Board" by the Ministry of Agriculture, Government of India would obviously accelerate the process of innovations in agriculture to link farmers to markets. Sooner it is done, better it will be in the national interest. The best example of this kind already exists in the dairy sector, namely the National Dairy Development Board (NDDB), which has not only helped in achieving "White Revolution" but has organized small and even landless dairy farmers to form rural cooperatives, thus, linking them to markets as well as consumers while ensuring regular income.

Scientist Farmer Dialogue

- A regular mechanism of scientist – farmer dialogue would certainly accelerate the process of agricultural innovations and hence, be put in place at the national level by the organizations such as ICAR.

A System for Quality Saplings, Planting Materials and Organic Agriculture Needed

- Currently, the importance of both 'seed' and 'rights' necessitates emphasis on availability of quality saplings and planting materials of horticultural crops, as also for other tissue-culture materials. Accordingly, there is need for enforcement of the quality standards of seedlings and registration of nurseries and other agencies dealing with planting materials. Likewise, standards and appropriate testing system of organic agriculture was felt necessary for promotion of organic farming. Thus, in national interest, notified laboratories were needed for quality testing of organic produce under both public and private domain.

Innovative Use of Various Legal IPR Tools for Economic Gains

- Presentations by farmers on their innovations and new initiatives were appreciated by all the participants. It was quite clear that the farmers need advisory services as well as other technical and financial support for recognition of their innovative efforts to logical conclusions.
- Each IPR-related Act recognizes and provides protection in a specific form. To effectively harness commercial value of extant varieties and other farmer' innovations, provisions of different IPR Acts should be appropriately made use of. Thus, agriculture commodities/goods which have international trade value and may qualify as geographical indications, should be got protected under the provisions of the Geographical Indications (Registration and Protected) Act. Of course, dual protection is also possible, if it is also protected as extant variety. Likewise, the trade mark protection can be sought for brand building of specific indigenous agricultural commodities in demand.
- The IPR and benefit sharing tools can be of great use to local and indigenous communities for conserving their agricultural biological diversity, and sustainably using their biological resources along with traditional knowledge. The innovative use of these tools and documentation system can bring the farmers due economic benefits from the traditional knowledge and genetic resource base. It can also help in preventing the unauthorized commercial use by others.
- NGOs and Farmers' Cooperatives have important role to play for value-addition and acknowledgement of farmer-led innovations. There is need to develop a national strategy for greater involvement of genuine NGOs and farmers' groups so that they are able to play a constructive role in the development of agriculture and allied activities in the country, and the rights of farmers are duly protected.

Need for Continued Germplasm Exchange

- Indian agriculture has gained tremendously by the exchange of germplam and the varieties of different crops with different countries all over the world in the past. Germplasm exchange (both import and export) will continue to remain the core basis for unhindered crop improvement work in future. The participants felt concerned about the difficulties in germplasm supply and receipt with the arrival of IPR and related Acts. It was felt necessary that concerned organizations, viz., the Biodiversity Authority, the PPV&FR Authority, the Ministry of Environment and Forests, the Ministry of Agriculture and the Indian Council of Agricultural Research must jointly address this important issue and work out appropriate and efficient coordination mechanisms. In this context, the advisory and functional role of

the National Bureau of Plant Genetic Resources was felt necessary, especially after the ratification of the legally-binding International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), and endorsement of the Standard Material Transfer Agreement (SMTA) by the Governing Board of the Treaty under overall umbrella of FAO.

Inter-Departmental Coordination Required for Reforms in the Indian Seed Sector

- It was general consensus that we need to address on priority some of the tasks that require gearing up of the Indian seed sector. These included; i) futuristic variety testing research; ii) services to international bodies like International Union for Protection of New Varieties of Plants (UPOV); iii) advisory services to other developing countries, iv) interface with Trade Mark (TM), Geographical Indications (GI) and Patent offices; v) interface with Value for Commercial Use (VCU) testing system; vi) service towards honoring the farmers' rights; vii) decisions on benefit sharing and compulsory licensing; viii) publication of plant varieties journal; ix) human resource development for scientific and technical aspects. Accordingly, it is critical that all relevant Departments should come together for a concrete action plan with deliverables to eliminate the difficulties of the Indian seed sector, such as, long drawn and much awaited revision of Indian Seed Act.

5. Farmer-led Innovations towards Plant Variety Improvement and Conservation: Protecting Farmers' Rights, Geographical Indications, Appellations of Origin etc. in the National Context

(A National Dialogue: November 12-13, 2006)

Background:

The farmer-led innovations, their art and science of growing and managing crop agriculture, design of farm implements to reduce drudgery and increase farm efficiency and their contributions to value addition in agricultural produce are important issues with regard to their appreciation value in the IPR and access and benefit sharing regimes. In this context, a specific focus is required on IPR related national Acts/laws, and also on the understanding of various dimensions of benefit-sharing requirements with the farmers to ensure continued innovations by the farming communities. A lack of understanding on protection of Farmers' Rights for their own varieties as well the requirement of programs to encourage other farmer-led innovations were some other important areas of concern, which called for a Dialogue.

A two-day national Dialogue on "Farmer-led Innovations towards Plant Variety Improvement and Conservation: Protecting Farmers' Rights, Geographical Indications,

Appellation of Origin etc. in the National Context" was held on 12-13 November 2006 at the National Agricultural Science Centre Complex, New Delhi. It was jointly organized by the Trust for Advancement of Agricultural Sciences (TAAS) and Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA); and was co-sponsored by Agricultural and Processed Foods Export Development Authority (APEDA) and Asia-Pacific Association of Agricultural Research Institutions (APAARI). The participants were from Government/Public sector agencies, ICAR, SAUs, international organizations, and other stakeholders representing academies, attorney firms, NGOs, private sector and farmers.

The deliberations were held in three technical sessions. The session-wise details and their recommendations are presented here:

Recommendations:

Need to Accelerate the Pace of National Seed Regulatory Reforms

- The uniqueness of Protection of Plant Varieties & Farmers' Rights (PPV&FR) Act of India is that along with grant of IPR on plant varieties it also recognizes the rights of farmers, besides considering the issues of conservation and benefit sharing with respect to crop varieties. The PPV&FR Act, therefore, entrusts important multiple responsibilities on the Authority created for the purpose.
- The many functions of the Authority include the task of characterization and documentation of varieties registered under the Act; and also documentation, indexing and cataloguing of farmers' varieties. Therefore, detailed documentation of crop varieties, whether developed by scientist breeders or farmer breeders, would be desirable.
- The efforts should particularly aim for technically competent and efficient crop variety testing, validation and seed quality enforcement system that meets all necessary requirements. The efforts should particularly ensure that the additional tasks in no way lead to the dilution of the existing testing system but rather strengthen it further.

Importance of Extant Crop Varieties as a Vital National Resource

- Under Section 2(j) of the PPV&FR Act, 'extant variety' includes: i) varieties notified under the Seeds Act, 1966; ii) farmers' variety; iii) varieties about which there is common knowledge; and iv) any other variety which is under public domain. Under Section 2 (i) of the PPV&FR Act, 'essentially derived variety' is defined with respect to the 'initial variety'. In conjunction with other provisions referring to 'extant variety' and 'essentially derived variety' in the Act, The 'extant' varieties are crucial for augmenting crop productivity and production in the country and with regard to implementing the provisions in the Act on "farmers' rights" and "benefit sharing".

- Awareness about the provisions and implementation of the PPV&FR Act among all key players in the private seed sector, which could be a key user of 'extant varieties' as 'initial varieties' was considered equally important. It emerged that improved crop varieties from the private seed sector, that are in cultivation but have not been notified under the Seeds Act, 1966 can also be considered for registration as 'extant' varieties under the category of 'varieties in public domain' or 'varieties of common knowledge', as per definition of 'extant variety' in the PPV&FR Act, and subject to availability of legally verifiable evidence.

A National Program on Farmers' Varieties and Innovations Needed

- Establishment of a national program for the recognition (identification) of farmers' varieties, including data verification may be desirable, along with appropriate rules for access and benefit sharing for the realization of farmers' rights. To verify the true expression of characteristics of farmers' varieties, their testing and validation may need to be done in the native area of their cultivation.
- Farmers' varieties generally possess preferred and economically important traits, which are also relevant to their trade value. A proposed directive on "conservation of varieties" under consideration by the European Commission has similarities with the case of farmers' varieties in the Indian PPV&FR Act. Accordingly, the concern was that there is no program, policy or window of opportunity for the enormous crop variety diversity at the farmers' level. Therefore, an institutional mechanism should be evolved for characterization, data generation and diffusion mechanism for the farmers' crop varieties as well as safe storage of seeds of these varieties in the National Gene Bank.
- In order to encourage farmer-led innovations, it was suggested that the PPV&FR Authority should institute special awards to recognize farmers, including women farmers, for their valuable contributions.

Establishment/Accreditation of Laboratories and Institutions for Crop Variety Testing

- Establishment of new or accredited institutions for field testing for Distinctness, Uniformity and Stability (DUS) of new varieties, to be registered under the PPV&FR Act, need to be given a priority. The testing system being envisaged must be critically viewed for its competence and effectiveness and should build on existing system with required efficiency and reforms.
- The provision of 'Essentially Derived Varieties' in the PPV&FR Act necessitates testing of new varieties at the biochemical and molecular level. Thus, there will be need for establishing accredited laboratories for this purpose as well.

6. Models of Public-Private Partnership in Agricultural Biotechnology

(A Brainstorming Session: April 7, 2007)

Background:

India experienced unprecedented success with cultivation of Bt Cotton. This success has its foundation in partnership between public institutions, private entrepreneurs and farmers. Over the years, similar partnerships have been developed among different sectors; the examples are golden rice and fruit borer resistant brinjal. It is expected that more such partnerships will emerge to overcome impediment in agricultural development.

Recognizing the need to initiate a dialogue on public-private partnership involving all the concerned stakeholders, APCoAB along with APAARI and TAAS organized a "Brainstorming Session on Public-Private Partnership in Agricultural Biotechnology" in 14 March, 2005. The session was attended by experts on crop biotechnology, crop breeding, IPR, policy and planning, representing NARS, government science and technology departments, CGIAR Centers, private sector and NGOs. One of the recommendations of the Brainstorming Session was to define specific models of partnerships that could be considered by the policy makers for starting negotiations and taking decisions. The "Brainstorming Session on Models of Public-Private Partnership in Agricultural Biotechnology" held by TAAS on 7 April 2007 is a follow-up of this recommendation. It was attended by 46 participants including policy planners and scientists from government departments, Indian Council of Agricultural Research (ICAR), private sector, CGIAR centres and non-government

Group Photograph taken during Brainstorming Session

organizations (NGOs). The group deliberated on the emerging issues and came out with following recommendations:

Recommendations:

Models of PPP

In view of the highly diverse nature of agricultural biotechnology projects operating successfully in partnership mode, no single model can be the most appropriate one at large. However, recommendation emerged for some basic requirements that are essential for making a public-private partnership (PPP) successful, as follows:

- The partnership should be based on common goals of the partners to achieve objectives of mutual interest that are also aimed at addressing national challenges in agricultural growth and farmers' incomes.
- The partners should have matching resources which also complement mutual strengths.
- The partnership should be built on mutual trust and commitment to create a dynamic and result oriented working environment.
- The output of the partnership should be more than the potential of individual partners.
- The existing PPP models should be analyzed to develop appropriate guidelines for entering into future partnerships and for negotiating terms of benefit sharing.
- PPPs need to consider partnering seed industry, including seed associations, to enable expeditious multiplication and distribution of the seed to farmers.
- All projects should be analyzed for freedom to operate from IPR perspective before these are implemented.

Policy

- A Senior Level Working Group comprising ICAR/DBT/DST/IITs/universities should be constituted to frequently review the technological developments in the public sector and identify the appropriate ones which are fit to be commercialized in a partnership mode. Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB) could facilitate identification of potential partners in a network.
- All partners must ensure that the project at any stage does not adversely impact ecology and biodiversity.
- With changing perceptions of partnership in a globalized world, multinational companies may be considered at the same level as Indian national companies for entering into partnerships with public sector.
- Private sector needs to make long-term investment in basic and strategic research in molecular marker aided selection, genomics and bioinformatics,

and enter into partnerships with public sector right from project inception stage.

Capacity Building

- There is a need for building comprehensive infrastructure and human resource in public sector for biosafety and transgene testing.
- Human resource development in public sector institutions on technical and legal aspects of IPRs is essential to build capacities and forge partnerships.

7. Farmer-Led Innovations for Sustainable Agriculture

(A Symposium: December 14-15, 2007)

Background:

Innovations made by farmers have contributed tremendously to the advancement of agriculture. They have traditionally conserved indigenous genetic diversity, selected new genotypes, developed innovative farming techniques to mitigate oncoming challenges and developed new tools to help in overcoming day-to-day operational drudgery. This knowledge has, by and large, remained undocumented and unrecognized.

A symposium on Farmer-Led Innovations for Sustainable Agriculture was organized at the Birsa Agricultural University, Ranchi, on 14-15 December, 2007

Inauguration of the Symposium

in collaboration with TAAS and NAAS. It was also co-sponsored by the PPV&FRA, Govt. of India and the National Rainfed Area Authority. The symposium was attended by a large number of innovative farmers, officers and the scientists from Birsa Agricultural University, Ranchi, ICAR Institutes and the representatives of PPV&FRA, TAAS, NRAA, and NAAS. The recommendations emerging out of the discussion held are as follows:

Recommendations:

Participatory Development and Institutional Support

- Farmer-led innovations are both realistic and more imaginative to address location specific problems. These are also aimed at sustainable agriculture. Despite, in many cases, lacking the scientific explanations, farmers' practices are invariably practical and sound. Therefore, we need to document and disseminate such innovations for wider adoption.
- Indigenous technical knowledge (ITK) has to be blended with scientific innovations through participatory research approach. This would require concerted efforts for research reorientation and change in the mindset of scientists. Also, institutional support for scientific documentation of ITKs would be needed as a matter of priority.
- Farmer-led innovations would often require validation and refinement for which State Agricultural Universities (SAUs) and ICAR Research Institutions could provide laboratory equipment and facilities through establishment of Technology Parks (TP). Benefits of such refined/improved technologies could be shared among the farmer entrepreneurs and the concerned scientists/ institutions through commercialization.
- Organic farming offers greater opportunities for higher income to producers and better health to the consumers. Production and marketing of products of organic farming would require effective quality control and assurance to the consumers. For this, there is an urgent need to establish quality control laboratories for testing various farm products.
- Protection of IPRs would be a pre-requisite for facilitating assured access as well as benefit sharing. Hence, creation of IPR cells in all institutions/SAUs and their strengthening would be required, if not already created.

Linking Farmers to Markets

- For enhanced income and due share in the price of farm produce, it is imperative to link farmers to the markets (LFM). For LFM, it is necessary to have value addition through adoption of low cost, rural based post-harvest technologies (PHT) with appropriate storage/marketing facilities. Besides, market intelligence through effective use of information and communication technology (ICT)

would enable proper decision making. All these initiatives would also help in generating employment for the rural youth, besides additional income to the farming community.

Policy

- Currently, a top-down mechanism of research prioritization is being practiced, whereas a bottom up approach involving farmers, private sector and NGOs, is needed to make it more relevant. In addition, this process will also help in better ownership and participation of all stakeholders as well as identifying specific research gaps that need to be addressed on priority.
- For adoption of new innovations, initiatives such as Institute-Village Linkage Program (IVLP) has to be expanded to cover different agro-climatic regions of the country. This is important since most of the extension systems for technology transfer, operative in the past, are either non-existent or non-effective in the present context.
- For required awareness among young generation, it is necessary that history of Indian agriculture is taught both at the school and college levels, as is being done for the science subjects. Knowledge of agriculture is, indeed, essential being an important sector of our National economy.
- Farmers' role for protecting the germplasm, such as the landraces and varieties of different crops including the underutilized, medicinal and aromatic plants, has to be recognized and the Farmers' Rights need to be protected. Also, mechanisms are needed for streamlining access and benefit sharing, besides registration and protection of valuable germplasm materials.
- The national seed regulatory reforms need to be accelerated to promote the seed industry and bring much needed benefits to those engaged in varietal improvement, maintenance, conservation and seed development activities.
- In order to enhance the farmer-scientist interface, a non-political Forum/ Body has to be established at the national level for required facilitation. Hence, there is an obvious need for the creation of an Organization/Agency/ Board/Authority at the National level for the authentic documentation and promotion of farmers' innovations in order to accelerate new innovations in agriculture.

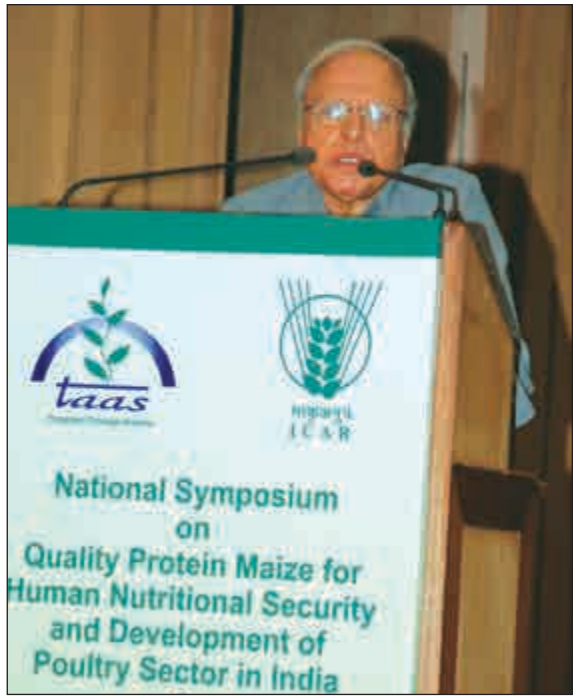
8. Quality Protein Maize for Human Nutritional Security and Development of Poultry Sector in India

(A National Symposium: May 3, 2008)

Background:

Maize has enormous potential for providing nutritional security to the under nourished globally. Endowed with high content of carbohydrates, fats, proteins,

important vitamins and minerals, maize has acquired the reputation of poor man's nutritious food. The recent development of maize with nutritious protein, quality protein maize (QPM), assumes special significance. However, there are some issues which need to be addressed before fully exploiting the potential of QPM. The symposium was organized by TAAS and Directorate of Maize Research on 3 May, 2008 at NASC Complex, DPS Marg, New Delhi to discuss this subject of considerable importance. This symposium was attended by 150 delegates. The important recommendations made by the experts are given below:



Dr. M.S. Swaminathan inaugurating the Symposium

Recommendations:

Policy

- Maize should be included in the National Food Security Mission, in addition to the existing thrust on wheat, rice and pulses. It is because of the potential of maize not only in meeting the food and nutritional security, but also the influence it will have on the growth of allied sectors, viz., poultry and livestock production.
- There is an urgent need to bring about 80 – 90 per cent area under single cross hybrids, which at present is rather low. Since QPM hybrids are basically bred by the public sector institutions, and the public seed agencies are unable to meet the demand for seeds of these hybrids, a Public-Private Partnership model needs to be promoted to achieve the desired area coverage.
- Maize crop has a wide range of adaptability, beside great potential for adaptation to climatic change. In addition, maize has also demonstrated a very high growth rate (about 4.5% p.a.) during the last one decade. With emerging problems of water scarcity, rising temperature, etc., maize seemed to have good potential both for vertical and horizontal expansion. There is need to have diversification of rice-rice and rice-wheat cropping systems in the peninsular and eastern India, respectively.

- Currently, utilization of maize as food crop is only 25 per cent, whereas its use for animal and poultry feed is almost 60 per cent. Hence, increasing area under QPM could lead to improved human nutrition and availability of low-cost high quality feed for which internal demand is increasing at much faster pace. This would demand use of variable maize products and change in the food habit through popularization of various maize recipes. Also, QPM could be a cheaper source of protein for the children and can thus be used effectively as mid-day meal for which Bihar State has already taken good lead. It also has relevance for inclusion in the Rural Employment Guarantee Scheme.
- Maize has also demonstrated its adaptation ability in areas where the rabi temperatures rise suddenly rather than gradually, as being the case in the eastern states including West Bengal. 'Single cross hybrids' of maize can play a significant role in these areas.
- Utilizing maize as nutritious animal feed would demand faster growth of bio-and organic fertilizers like poultry droppings. This will help in improving the health status of our soils.
- Poultry sector has enormous growth potential (about 15% p.a.) as compared to the present level of 11 – 12 per cent. Poultry industry would raise further the demand for QPM. Besides, maize has tremendous export potential, especially in South East Asia.

Incentives and Resource Allocation

- Maize being the best quality feed for poultry, it is necessary to provide incentives to those farmers who produce QPM. Government could consider giving a premium price to the QPM growers so as to accelerate its production in the country. In this context, State Department of Agriculture, Govt. of West Bengal has already taken major initiatives for seed production of the QPM hybrids through public-private partnership.
- The fast growth of maize wet as well as dry processing industry demands that it is included in the 'identified' schedule crops of the food processing industry. This would ensure stable prices for maize processed products in the market and would benefit both the producers and consumers.
- More thrust is needed now both on research and development of QPM maize, for which additional resources need to be allocated as a matter of priority.

9. Emerging Challenges before Indian Agriculture – The Way Forward

(A Brainstorming Workshop: March 6, 2009)

Background:

India has made great strides in increasing food grain production. In the recent past, particularly significant progress has been made in achieving increased growth

rates in horticulture, livestock and fishery. Nevertheless, declining total factor productivity, diminishing natural resources and stagnating farm incomes have caused serious concerns.

This workshop was organized by TAAS in collaboration with IFPRI on 6 March, 2009 at NASC Complex, DPS Marg, New Delhi for an in-depth discussion on the emerging challenges that constrain agricultural growth and finding ways of overcoming these. The workshop was attended by 44 participants. The recommendations emerging out of the workshop are given below:

Recommendations:

Policy

- Increasing agricultural productivity is a key challenge for ensuring national food security. To increase production, exploiting the potential of existing yield gaps offers a tremendous opportunity. Hence, a Mission Mode Program on "Bridging the Productivity Gap" with missionary zeal and effective monitoring is required to be launched with meticulous planning as a matter of priority. For this, greater attention to agriculture in the national policy is needed, and the existing technology dissemination and input supply system needs to be revitalized and tuned to meet the emerging needs of farmers. Special emphasis on seed sector, input use efficiency, financial and insurance institutions and a paradigm shift in technology transfer mechanisms involving both the private sector and NGOs would be critical in achieving the desired goals.
- Rainfed areas have a huge potential to raise production and increase farm income. These grey areas can soon be made green to harness a second green revolution. Role of technologies, policies and infrastructure would be very important in realizing the potential of rainfed agriculture. In this context, it has to be ensured that public policies and technologies have appropriate synergies to move forward. The initiative of the Government of India to establish the 'Rainfed Area Authority of India' is a welcome step. However, this Authority needs a proper policy framework, legal and funding supports as well as empowerment for effective coordination and monitoring of all rainfed related programs run by various Ministries/Departments. The sooner it is ensured, the better it would be in the national interest as time is otherwise running out.
- Linking farmers to markets is a pre-requisite for augmenting farm production and farmers' income. Role of innovative institutions would be critical in this context to reap the benefits of emerging opportunities. A silent revolution of innovative institutions is already taking place in the Indian agricultural production and marketing system (farm to plate continuum) encompassing effective functioning of value chains and marketing efficiencies. The current

need is to replicate such 'best practices' through formation of producers' associations and self-help groups or cooperatives so as to harness fair and efficient contract opportunities through value addition by organizing the farmers. Krishi Vigyan Kendras (KVKs), constituting an existing institutional mechanism at the district level, could play a very important role in the entire supply chain through access to best practices in production to marketing continuum. Information and communication technology offers new opportunities in support of this.

- There is a dire need to significantly expand the capital investment in agriculture by both public and private institutions in the non-green revolution regions, particularly in the eastern and north-eastern India, where there is a great potential for agricultural growth. Hence, investment priorities must now be oriented towards realistic accelerated growth of agriculture for meeting the growing needs of the population. Therefore, public policies should be such that these trigger the much needed private sector investments for infrastructure development.
- Agriculture is confronted with new forms of risks and uncertainties. These are related to natural calamities, global climate change, use of food for biofuels, uncertainty over prices, etc. Role of knowledge system and institutional mechanisms for input supply, credit, crop and livestock insurance, etc., would, therefore, be important in reducing both risks and uncertainties in order to attain the much needed resilience in Indian agriculture. At the same time, less dependence on the use of chemical fertilizers and pesticides, and efficient use of water, energy and other inputs, including timely farm operations with major emphasis on small farm mechanization and bioenergy (solar and wind), would help achieve faster growth in agriculture.
- Water will be the most critical natural resource for the future growth of agriculture. Currently, the water sector for irrigation is invariably neglected both at the central and state levels. High inefficiencies in water delivery, distribution and on-farm use are adversely affecting our agricultural production. Irrigated area can be expanded considerably with improved efficiency in water use. Innovations in governance and pricing of surface and ground water for the desired water use efficiency, through an integrated approach among irrigation department, private sector, and farmers' water user associations are urgent issues for coordinated action by all stakeholders.
- Climate change has added a new dimension to future agricultural growth, which is a major concern. The worst affected would be small farm holders located in the marginal and under-privileged areas. Therefore, investment options for both adaptation and mitigation, and policies which can help in reducing the impact of climate change, are urgently needed at this stage, especially to provide incentives to the small farm holders for the adoption

of technologies and practices such as conservation agriculture, carbon sequestration, etc., that can mitigate the impact of climate change.

- There is an urgent need for agricultural diversification by identifying the key crops/commodities which can help small farm holders to raise their income. Incremental gains in income through diversification will help capital formation which will be instrumental in attaining higher productivity and profitability. In this context, agro-ecological zone-wise planning, adoption of new area, new crops approach using geographical information system (GIS) and land use planning, and effective district level implementation of the strategy by involving grass root organizations and the stakeholders would be the best option to move forward.
- Food processing and distribution sector needs to be strengthened by evolving policies for greater private sector participation in the entire value chain. Incentives through appropriate tax structure should be such that agro-processing, especially in the rural areas, becomes a lucrative option both for the farmers and the private sector. Current post-harvest losses are also to be minimized for which construction of modern silos is a matter of national priority.
- Globalization of agriculture offers immense opportunities for enhanced agricultural export of a number of products. This can be harnessed only through increased efficiency in our production systems, improved quality of produce, value addition, market intelligence and long-term well targeted export policies and planning, supported fully well by an enabling environment both within and outside the country. An institutional mechanism, with emphasis on a single window system, would catalyze the whole process of agricultural exports from India, for which tremendous opportunities exist but have not been tapped presently.

10. Strategy for Conservation of Farm Animal Genetic Resources

(A Brainstorming Workshop: April 10-12, 2009)

Background:

India is a rich repository of flora and fauna. It has 132 registered farm animal breeds. These breeds have evolved under domestication and over numerous cycles of natural selection. They have special attributes of remarkable adaptability to tropical environment and genetic resistance to many diseases. However, recent human interventions have led to over exploitation of these genetic resources and threatened the existence of some of the precious genetic diversity. Today, faced with the needs of growing population and to meet challenges of climate change there is urgent need to conserve our valuable indigenous genetic resources for sustainable use of their 'resilience' traits.

Group photo with Governor during the Brainstorming Workshop

In order to discuss National and International issues pertaining to management of animal genetic resource, a brainstorming workshop was organized by TAAS and BAU Ranchi on 10-12 April, 2009 at BAU Ranchi to review the current status and develop strategies to conserve our animal wealth.

The group of participating experts, representing various stakeholders from national and international organizations, recommended and then unanimously adopted the following declaration, to be referred henceforth as "Ranchi Declaration".

Ranchi Declaration:

- We assert that India, without waiting for the stipulated time frame of 2011, should immediately prepare a National Plan of Action on management and conservation of farm animal genetic resources for its speedy implementation.
- Currently, the five livestock and poultry species, viz., cattle, buffalo, goat, sheep and chicken (poultry) are at the top priority in terms of population, diversity and contribution to the national food, environment and livelihood security. Therefore, we propose that these species be immediately declared as BIG FIVE of India.
- We recognize the enormous contribution of farm animal genetic resources to the national gross domestic product (GDP). During 2006-07, the contribution of livestock and fisheries sectors was estimated to be Rs. 2,508 billion which is about 5.26 per cent of total national GDP and around 31.7 per cent of our agricultural GDP. Hence, it is urged that current resources be doubled for the livestock R&D sector on priority, and a specific policy directive given in

favour of farm animal genetic resources that are so critical for the national food and nutrition security as well a sustainable livelihood of our resource poor farmers.

- We are convinced that maintenance of diverse animal genetic resources for food and agriculture is essential (especially for the farmers, pastoralists and animal breeders) to meet the current and future challenges arising out of climate change, increased press due to diseases, overexploitation of grazing lands and the changing consumer demand for animal products. Hence, maintenance and further improvement of pure breeds retaining their valuable characteristics, including those related to adaption to climate change, becomes a national priority.
- The role of farm men, women, pastoralists and rural communities in evolving different breeds of livestock and poultry, adapted to specific ecological niches, is fully recognized since, these breeds possess unique traits developed over many years of selection. In this context, we are convinced that a strong legal instrument is urgently needed to deal with the registration of livestock breeds, protection of animal keepers' rights and related issues for effective management and conservation of farm animal genetic resources, on a pattern similar to that of Protection of Plant Varieties & Farmers' Rights Act (2001).
- We especially recognize the need for capacity building of civil society organizations (NGOs and local livestock community/farmers) for managing Indian breeds of livestock and poultry and retaining their valuable characteristics and purity. In this context, the currently engaged staff at the Government Livestock Farms and some specialized *Gaushalas* be properly trained.
- It is acknowledged that major gaps/weaknesses exist in our national and state capacities to inventorise, monitor, characterize, sustainably use, develop and conserve animal genetic resources. These need to be bridged as a matter of priority through a mission mode program, and by developing the much needed population database for animals, their population trends and risks associated with them in order to establish country based early warning and response systems. Hence, there is an urgency to initiate appropriate action to conserve our valuable livestock and poultry breeds that are currently at risk.
- Considering available institutional strength and competent human resources, India could serve as a regional focal point for the management and conservation of farm animal genetic resources for South Asia. It would, therefore, be worth exploring this option through regional fora/organizations such as South Asian Association for Regional Cooperation (SAARC), Asia-Pacific Association of Agricultural Research Institutions (APAARI), etc.

- We recognize the need to strengthen research aimed at scientific management, genetic enhancement, sustainable use and conservation of farm animal genetic resources. This has to be accomplished through effective coordination linkage mechanisms among various ministries/departments and the partnership with regional and international organizations/institutions such as FAO and International Livestock Research Institute (ILRI).
- This Ranchi Declaration was adopted on 12th day of April, 2009.

11. Climate Change, Soil Quality and Food Security

(A Brainstorming Workshop: August 11, 2009)

Background:

The major challenges to sustaining food productivity attained as a result of the Green Revolution of 1970s include feeding rapidly growing population, shrinking natural resources and risks associated with climate change which are impacting agriculture in many ways. Unforeseen changes in temperature and precipitation call for the measures for mitigation and adaptation in our agriculture, including cultivation of appropriate varieties and adoption of better agronomic practices.

In order to discuss these issues, a workshop was organized by TAAS on 11 August, 2009 at NASC Complex, DPS Marg, New Delhi attended by 51 participants. The participants comprising leading agricultural experts from national and international organizations, policy makers, scientists, leaders of corporate organizations and civil society discussed these issues intensively and came out with following recommendations:

Dr. H.S. Gupta, Director IARI presenting welcome remarks

Dr. M.S. Swaminathan, Chairing the Plenary Session

Recommendations:

Policy

- Per capita availability of land in India is likely to decrease substantially (around 0.09 ha by 2050) with the current growth in population. This coupled with the challenge of rising food demand necessitates an urgent need to double the resource allocation for agricultural R&D to focus on increased irrigated area, improved efficiency of water and fertilizer use, and improvement in the health of our degraded land. Immediate action on these R&D aspects is needed to address the emerging threats in the context of climate change and food security.
- Increasing weather aberrations and consequent risks are likely to impact adversely on Indian agriculture. Severity of these risks will get compounded with climate change or especially in terms of increasing temperature, erratic rainfall and rising sea level. It is estimated that cereal productivity may decrease anywhere between 10 and 40 per cent by 2100 if no corrective measures are taken in time. Hence, adaptation to climate change must receive high priority by all stakeholders.
- The role of R&D, especially in conserving natural resources like land and water, assumes significance for adoption of a strategy aimed at mitigation and adaptation to climate change. Conservation agriculture ensuring minimum disturbance of soil, increased vegetative cover, and diversification of crop sequences which has a lot of potential. However, adoption of new innovations would require proper policy, funding and institutional support.
- Achievement of the Millennium Development Goals (MDGs) in the event of climate change is likely to become more difficult, especially in South Asia where high incidence of poverty and malnourishment is rampant. In such a scenario, the achievement of MDGs would obviously require global/regional research partnerships, and sharing of information and experiences. In this context, organizations such as Asia-Pacific Association of Agricultural Research Institutions (APAARI), Global Forum on Agricultural Research (GFAR), CGIAR Centers, Food and Agriculture Organization of the United Nations (FAO) and some advanced research institutions (ARIs) like Japan International Research Center for Agricultural Sciences (JIRCAS) have to play an effective role in bringing all stakeholders together for research partnerships and capacity building.
- The Agricultural Research and Education System must be reoriented to respond effectively to the emerging challenges of natural resource degradation, and climate change. As stated before, there is an urgent need to double the agricultural R&D allocation to meet the new challenges being faced by Indian

agriculture. The policy mismatch for different sectors of agriculture should also be looked in while making future R&D allocations.

Strategy

- To cope with climate change, the strategy should mainly entail adaptation to changing environment (new genotypes), and efficient use of resources (land, water, energy) as well as weather management services. Additionally, the long term mitigation strategy should aim to neutralize the factors such as greenhouse gases (GHGs) causing climate change.
- Adaptation and mitigation strategies would require strong R&D back up as well as proper financial and policy support. Diversity of agricultural systems, experiences of Green Revolution and new innovations are the keys to understand the processes that would accelerate both adaptation and mitigation. Mostly, these strategies should evolve around new plant types, appropriate land use planning, and efficient management of crops as well as available natural resources (biodiversity, land, water, energy, etc.).
- Crop improvement through traditional plant breeding, and biotechnology tools, should target better tolerance in crops to drought, heat, salinity, floods, etc. This could be done through breeding for earliness, adaptability to fragile ecosystems, improved plant architecture, and tolerance to pest dynamics. The strategy should also aim at the exploitation of alien genes as well as new genes for gene pyramiding, converting C_3 plants to C_4 plants, and building multiple resistance to both biotic and abiotic stresses, etc.
- Rainfed agriculture occupies nearly two-thirds of our agricultural land where water is the most scarce resource. Hence, increasing water-use efficiency through measures such as sprinkler irrigation, drip irrigation, use of plastic mulch and water harvesting (through bunding around small farm holdings) becomes an essential part of the proposed adaptation strategy. It is estimated that nearly 11- 37 per cent runoff can be utilized by simple means like field bunding and land leveling, to successfully raise one crop in almost 25 million ha of rainfed area. However, this will require proper technical backstopping through a responsive and efficient extension system, involving both public and private institutions, particularly NGOs active in rural areas.
- Improvement in soil fertility and productive capacity of ecosystem should evolve around the increasing carbon pools both in soil and vegetation. Trading of carbon, similar to other farm commodities prevalent in developed countries, can create another stream of income for farmers. However, special incentives to small and resource poor farmers for adopting resource conserving technologies/ environmental services need to be provided since these initiatives are in overall national interest. For this, we need to pursue the strategy of

learning through change that will improve our soil and ecosystem, and bring in resilience in agriculture.

- Soil carbon sequestration is an effective strategy to improve soil health and raise crop yields. Somehow, available soil organic carbon (SOC), in most uplands in India, is only around 0.2-0.5 per cent, which is much below the threshold level (around 1.1%). Application of soil amendments such as crop residues and animal manure can enhance SOC pool significantly in rainfed areas, and hence be promoted. Burning of wheat and rice straw should be stopped/banned and farmers should be encouraged to adopt organic recycling to improve soil health and raise crop productivity.

12. Quality Seed for Food Security through Public-Private Partnership

(A National Seminar: April 13-14, 2010)

Background:

In order to meet growing need of quality seed to ensure food security, public-private partnership is necessary. This will help in reducing the gaps in seed chain and developing buffer stocks of quality seed to meet urgent requirements during natural calamities. In order to discuss these issues a 2-day seminar was organized jointly by the NSAI, TAAS and IARI on 13-14 April, 2010 at IARI, Pusa Campus, New Delhi.

Presidential address by Dr. R.S. Paroda

In all, 142 participants comprising private entrepreneurs, scientists and representatives of National Seed Association of India (NSAI) discussed various issues and came out with following recommendations:

Recommendations:

Policy

- A Policy Paper needs to be brought out immediately based on crop-wise desired and current seed replacement rates (SRR), total seed requirements and availability, giving varietal shares and strategy to be followed to increase crop productivity by increasing the SRR. The ICAR should coordinate with the Department of Agriculture & Cooperation (DAC) and NSAI to bring out this paper to form the basis for strengthening of seed development program in the country.
- Increased availability of high yielding variety (HYV) seeds can fast bridge the yield gaps and thus, increase the national productivity and production. Hence, there is an urgent need for the ICAR to enhance the SRR of selected crops and vegetables, with emphasis on improved varieties of pulses and groundnut, where the SRR is still far from satisfactory. Wherever hybrids are successful, a special drive to increase the area under them would be desirable. For instance, in rice, the area under hybrids can be enhanced from the current 1.5 million hectares to at least 5 million hectares in the next Five Year Plan period. Similarly, in maize, the production can be doubled by increasing the area under single cross maize and QPM hybrids from the current 40 – 50 per cent to at least 70 – 80 per cent in the next 4 to 5 years.
- The success of partnership lies in trust, openness, and transparency. This can be built by regular interactions and dialogues, and appropriate policy framework to strengthen public-private partnerships. Therefore, a Standing Working Group in the Ministry of Agriculture (DAC/DARE-ICAR) may be constituted as a matter of priority under the leadership of an eminent scientist, comprising, in all, around 7 members representing DAC (2), ICAR (2) and seed industry (2). This could work as a "Think Tank" and play an oversight as well as honest brokers role in promoting public-private-partnership (PPP). The proposed Working Group could also review the existing guidelines for incentives and rewards and suggest ways for building new partnerships while taking care of access and benefit sharing (ABS) mechanisms.
- Good models and success stories on PPP existing in the NARS and the CGIAR system, such as that of IARI, NRCPB, IIHR, ICRISAT, IRRI, etc., can be replicated or further refined, as needed, by other institutions/ universities. However, some of these institutions expressed concerns about the break in the continuity of Breeder Seed procurement by the commercial organizations, which has to be addressed to build partnership.

- For the access to new hybrids/varieties/genetic materials, the private sector may consider paying royalties between 3-7 per cent on sale proceeds – based on negotiations, on a case to case basis, and depending on exclusive/ non-exclusive rights. The public sector seed corporations should also join hands with the research institutions in popularization and fast delivery of improved varieties, especially the hybrids. In view of the poor conversion of breeder seed to foundation and certified seed, the public sector should use PPP model to convert the maximum of breeder seed to certified seed. The public sector should, henceforth, pay a royalty on breeder seed on mutually agreed terms.
- There is an urgent need to build crop-based/institution-based technology parks/ incubators so that scientists from both public research institutions and private seed sector could work together right from the beginning of the partnership in evaluating germplasm and breeding lines, and in developing, evaluating and commercializing varieties with the desired traits. This may encompass the development of transgenics, biosafety assessment, field evaluation, public awareness and release of the final product keeping in mind the national interest.
- Germplasm conservation through use can help in achieving both sustainable agricultural growth and development. Hence, it was emphasized that the national germplasm collection available at the NBPGR, being the national public goods, be made available more freely on request, to Indian scientists/ institutions/seed companies engaged in crop improvement (R&D) programs. For this, the Standard Material Transfer Agreement (SMTA), as adopted recently by the FAO International Treaty on Genetic Resources for Food and Agriculture (ITGRFA) for multilateral access, can be adopted for immediate implementation, with necessary safeguards as needed. All data on available germplasm must be documented / catalogued and placed on NBPGR website.

Some of the policy related issues for consideration of the DAC are

- The DAC needs to harmonize, to the extent possible, seed related regulations both at the central and state levels. The New Seed Bill, currently under consideration of the Parliament, is expected to provide enabling environment for faster seed sector growth in the country.
- The quality seeds, whether certified or truthfully labeled, must qualify for seed subsidy. Subsidies need to be linked to promote area coverage under new HYVs and hybrids for increasing productivity, irrespective of whether produced by the public or private sector. This will benefit both farmers and the nation and avoid discrimination, which otherwise is counterproductive.
- For accelerating hybrid seed production, the present system of receiving indents of the parental lines of notified hybrids by the public/private sector

(through NSAI to DAC) and fixing one uniform price, irrespective of their commercial value, must be reviewed at the earliest in consultation with ICAR and NSAI.

- For crisis management, it is essential to establish Regional Seed Banks as a contingency measure. There is an urgent need for establishing Seed Processing and Storage Facilities by the public / private sector for common use, on a fixed charge basis.

13. Building Leadership in Agricultural Research Management

(A National Dialogue: August 27-28, 2010)

Background:

Agriculture sector is currently facing complex challenges including those in agricultural research. Funding crisis, declining scientific manpower, growing in-breeding in an era of complex problems as well as new opportunities in agriculture sector call for leaders who could become effective agents of change to effectively/ efficiently address these challenges.

A National Dialogue on "Building Leadership in Agricultural Research Management" was organized on 27-28 August, 2010 at NAARM, Hyderabad to provide a forum to the leaders and stakeholders to discuss various issues and options for building effective leadership in order to revitalize the NARS.

The conference was inaugurated by Dr. M.V. Rao, Chairman, Agri-biotechnology Foundation and Former Special Director General ICAR, and addressed by Dr. Mangala Rai, Director General, ICAR. Senior ICAR management staff, including

Group photograph of the delegates

50 delegates from various organizations such as Centre for Organizational Research and Development, Administrative Staff College, Department of Biotechnology, CGIAR and some corporate houses participated in the dialogue.

Discussions in the National Dialogue focused on the leadership development strategies needed for the National Agricultural Research System (NARS). Some of the major recommendations that emerged during the Dialogue are given below:

Recommendations:

Desirable Leadership Attributes

- The desirable attributes for leadership in agricultural research management must include: managing self, managing research for quality and development of science, facilitating partnerships and institutional linkage mechanisms, managing scientific teams and facilitating change in the organization. A leader must inspire, build confidence among colleagues, be consultative, should be able to manage conflict, delegate power with accountability, should be accessible, honest and transparent in decision making.
- Emphasis need to be given on IQ (Intelligence Quotient) and also on EI (Emotional Intelligence), which is rather more important for a leader to be successful.

Building Leadership

- There is a need to create awareness and required competencies among prospective leaders for 'servant leadership'.
- There is a need to understand new challenges, and develop commensurate re-engineering exercises to identify clearly what kind of leadership is required to overcome these challenges.
- There is a need to develop a mechanism to monitor scientists, for their extra-ordinary performance and potential leadership qualities, and then to groom them for taking up leadership responsibilities.
- Decentralized structure and performance-based rational and transparent evaluation in a collective mode would provide proper platform for developing research management leadership.

Other Related Issues

- In-breeding in the institutes must be discouraged.
- Bright young students should be encouraged to take up agriculture as profession. There is an urgent need to attract good students in agriculture and agricultural research system.
- A formal training in management should be an essential qualification for Research Management Positions

- For best management practices, appropriate models for different institutes, as per their size and specific needs, must be evolved.
- Distinction between performers and non performers be made more judiciously and in transparent manner.
- System wide mechanisms and incentives (both monetary and non-monetary) should be developed and put in place to attract talented scientists towards management cadre.
- Autonomy, freedom to experiment/play with ideas' (at least 15% of the time), and 'freedom to fail' would encourage leadership potential.
- Necessary rules and guidelines should be developed/put in place in the system to ensure quick decision-making.

14. Prospects of Producing 100 million tons of Wheat by 2015

(A Brainstorming Session: December 18, 2010)

Background:

Demand for wheat will increase substantially due to increase in population and practically no option for horizontal expansion of cultivable land. Well thought of measures are, therefore, needed to meet this challenge through vertical expansion i.e., by increasing the productivity of wheat to a substantial level.

A total of 91 wheat experts from India, CIMMYT and ICARDA represented by Dr. Rajaram (World Food Laureate) attended the Braining Storming Session on

Dr. M.S. Swaminathan Inaugurating the Brainstorming Session

18 December, 2010 at NASC Complex, DPS Marg, New Delhi. Based on detailed deliberations, the following recommendations had emerged:

Recommendations:

Policy

- Food security in India is synonymous to wheat production. Hence, consistent efforts would be necessary with adequate policy support to increase wheat production to meet our ever-increasing demand despite numerous challenges such as: factor productivity decline, high cost of inputs, poor soil health, low quantity and quality of water, and adverse impacts of climate change.
- Almost a decade ago, India had become number two in wheat production by surpassing the USA with almost same acreage. It must now aim to be number one by achieving higher production than China (currently 112 million tons). In this context, there is no room for complacency. Concerted efforts are needed under national food security mission to coordinate AR4D initiatives, especially to accelerate wheat production efforts in eastern India, and in those States whose average wheat productivity is still lower than the national average.

Research and Technology

- Nutrient application in the form of fertilizers and pesticide use will become more expensive due to high energy costs. Similarly, water scarcity will be a major challenge. Hence, it is important to develop varieties that are both water and nutrient use efficient. This can be achieved through appropriate crop improvement and crop management strategies in an integrated manner. It would require intensified crop improvement efforts and more extensive use of germplasm, synthetic wheat breeding and use of biotechnology. In this context, wheat breeding efforts in the country must immediately be strengthened and capable human resource employed.
- The major focus of the researchers should now be on enhancing the yield, which has been stagnating for almost a decade. To overcome specifically this challenge, both breeding and biotechnological approaches for developing hybrid wheat appears to be a viable option. To address this, public-private partnership should be encouraged through much needed policy environment and support, especially to ensure quantum jump in wheat productivity.
- Marker assisted wheat breeding will play a pivotal role and there is need to develop efficient markers for traits such as yellow rust, stem rust, grain quality, etc. Transgenics in wheat should be developed, especially for abiotic stresses, like terminal heat, drought and other traits like herbicide resistance, grain quality improvement, tolerance to micronutrient deficiency, etc.

- Research on quality improvement has to be further strengthened as the country's consumer demand for improved quality wheat is increasing, since, there is a need now for various end uses like flour, pasta, bakery, etc. Also, wheat quality will be a critical factor in case of future exports, if any.
- There is a need to lay more emphasis on breeding for yellow rust resistance which potentially will be the biggest threat to wheat production in near future. Keeping in view the impact of climate change, constant vigil and preparedness is required to deal with new threats like leaf blast, *Fusarium* head blight and Hessian fly. Similarly, incidence of leaf blight is now spreading, which needs to be addressed as a new threat.
- There is an urgent need to integrate both crop improvement and management strategies, especially to find solutions to improve soil health that has been constantly drained due to intensive rice-wheat cropping system in the Indo-Gangetic Plains. Organic matter content in the soil has to be improved and need based application of nutrients to be applied in future.
- Burning of crop residues is leading to environmental pollution, in addition to the loss of valuable organic matter needed to maintain soil health. We must promote surface retention or incorporation of crop residues for better soil health, which is so crucial for increasing productivity and profitability.
- In the scenario of decreasing availability of good quality irrigation water, there is an urgent need to adopt and promote water use efficient technologies like laser land leveling, raised bed planting, wheat sowing using zero till drill etc. for higher productivity and profitability to the farmers.

Packages of Cultivation Practices

- Unfortunately, considerable area is under late planting, especially in the eastern Gangetic plains. Through an aggressive campaign, timely sowing of wheat for higher productivity has to be ensured, following the examples of Punjab and Haryana in the recent past.
- Substantial area in the eastern Gangetic plains is under rice-fallow. There is an urgent need to promote adoption of surface seeding and/or zero tillage to convert the single cropped area to double cropping for increased production of wheat. This option has to be pursued aggressively both by increasing area under wheat and cropping intensity in eastern India.
- Wheat can be grown as an intercrop with sugarcane by adopting bed planting technique or relay cropping with cotton. Therefore, future efforts be addressed towards farming system's research. Also, for increased system productivity, profitability and sustainability, summer mung in north western Gangetic plains must be promoted, since, excellent short duration, disease-resistant varieties of mung bean are now available.

Seed Systems

- Region-specific seed systems should be developed for ensured supply of quality seed of varieties suitable for different regions for achieving increased productivity. It was also felt that predominant variety must be phased out soon, since it has shown increased susceptibility to brown rust, whereas new resistant varieties are now available to replace it. This requires priority time bound action.

15. Stakeholders' Interface on GM Food Crops

(An Interface Dialogue: May 19, 2011)

Background:

Dr. (Mrs.) Manju Sharma presenting her views

Despite Green Revolution and several innovations, the challenge of food and nutritional security still looms large. In order to meet the food requirements of the ever increasing population, we would need to increase our food production from current 235 mt to at least 285 mt by 2020 from less cultivable land. GM technology provides powerful tools to meet this challenge. To discuss these issues, a dialogue was organized jointly by APCoAB, TAAS and ICAR on 19 May, 2011 at NASC Complex, DPS Marg, New Delhi.

Dr. S. Ayyappan and Dr. H.S. Gupta co-chairing a session

The recommendations given herein are a synthesis of the views of stakeholders emerged as a result of pragmatic in-depth discussions held. The meeting was attended by 45 experts representing a cross section of technical experts, scientists, policy makers, farmers and other stakeholders.

Recommendations:

- There is a need for second Green Revolution in India especially for our nutrition security, since India has the maximum concentration of malnourished children and anemic pregnant women in the world. It is also extremely important to have good nutrition rather than food calories alone. For this, the use of GM technology is highly relevant in the present context. This technology offers new options to enhance nutrition security through designer cereal, oilseed, pulse, fruit and vegetable crops and to meet the challenges of biotic and abiotic stresses as well as those of global climate change. Moreover, the poverty of small-holder farmers can be overcome by providing them new technologies that can reduce cost on inputs, build resilience in farming and increase their income by linking to the markets. In this context, we do see a prominent role of biotechnology, which needs to be harnessed on priority.
- Development and adoption of appropriate GM technologies would need a mission mode approach for which a strong public research system needs to be built/strengthened. Along with public sector, the private sector investments on GM technologies have to be enhanced for which an enabling environment is a must. Appropriate protocols and IPR regimes need to be developed to encourage public-private partnership.
- There is an urgency now for the prioritization of crops in order to effectively use GM technologies for improving specific traits. To achieve this, a National Mission on GM Food Crops be initiated soon, being a national priority, jointly by DBT and lCAR. It should be a time targeted and well monitored program linked to specific outputs.
- It was strongly felt that the Biotechnology Regulatory Authority of India (BRAI) Bill, which is already in the Parliament, must be cleared soon and a strong message in this regard needs to be sent to all concerned policy makers and authorities since we have already lost valuable five years. The proposed BRAI is also recommended in order to ensure a single window system for testing, clearance and monitoring. At the same time, the regulatory system should not be too stringent to slow down the release process.
- The biosafety regulatory system, though well defined and in place, needs to be made more efficient and fool proof so as to facilitate effective and safe application of biotechnology. We need a clear and well defined pathway and transparent system for which there is an urgent need to establish a few accredited laboratories in reputed public sector institutions like NIN, IARI, CDRI etc. having excellent infrastructure with modern equipments and well trained staff. Accreditation of some of these public sector laboratories is a must in order to build much needed public confidence. Also, a referral laboratory needs to be established so as to deal with any dispute arising on account of variations in results of different laboratories. There is no mechanism existing

presently for the seed testing of GM crops. Hence, efforts are needed to establish accredited laboratories for this purpose.

- There is also an urgency to have proper post-release monitoring system, for which a suitable mechanism be put in place jointly by ICAR and DBT. Also, need for undertaking survey on farmers' fields is justified in order to assess the uptake and impact of GM technologies. Socio-economic assessment should be an integral part of GM crops evaluation process. Also, opportunity costs of not adopting the technology should be a part of this assessment.
- Plant breeders and biotechnologists must join hands and work as one team to address specific research problems. Their efforts should be synergistic and not competitive. Similarly, strong public-private-partnership right from the beginning of the project, with needed understanding, mutual trust and defined roles for research and benefit sharing, be encouraged through enabling environment. This is a must for faster delivery to the end users of agricultural biotechnology.
- Public perceptions about GM technology are often not based on scientific facts. Information communication system, including public extension and awareness services, need to be considerably improved in order to effectively deliver correct and unbiased information to farmers and the general public. Also, there is an urgent need to properly inform and educate people at all levels, including policy makers and planners, farmers, consumers and other stakeholders on all aspects of agricultural biotechnology and biosafety. Required communication tools must be used for effective delivery of knowledge.
- Priority investments are needed on capacity building, especially in areas of biosafety research, regulatory systems (including legal aspects), communication tools and IPR issues since they are all critical for out-scaling innovations for greater impact.
- There must be a defined focus on agri-business and agri-biotechnology in the 12th Five Year Plan for which ICAR should take a major initiative and DBT must extend required funding support. Agri-business platforms and technology parks have to be established for building much needed public-private-partnership and for faster delivery of GM products to both farmers and consumers.

16. Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences

(An International Conference: November 9-12, 2011)

Background:

Globalization of economy, changing structure of rural economy and emerging issues such as climate change have opened up new avenues and challenges in agriculture

Chief Guest Shri Harish Rawat, Hon'ble Union Minister, Food Processing Industries, and Parliamentary Affairs gracing the Valedictory Function

and enhanced the need for timely and accurate information as one of the drivers of agricultural growth. This situation demands for a continuous search for new methods and approaches for generating, processing and sharing of agricultural knowledge communication by various stakeholders for augmenting agricultural production and productivity. Apart from innovativeness in methods, there is consistent effort to bring in innovativeness in increased level of partnership between public and private sectors in agricultural technology generation and sharing so as to improve efficiency of agricultural knowledge system.

In this context, an International Conference on "Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences" was organized from 9-12 November, 2011 by ICAR, International Society for Extension Education and TAAS in collaboration with Maharashtra Society of Extension Education, National Academy of Agricultural Sciences, Alcorn State University, USA, APAARI, FAO, GFAR, and Iowa State University, USA at the NASC Complex, DPS Marg, New Delhi.

The conference had 23 technical sessions and two special sessions. The conference was inaugurated by Smt. Pratibha Patil, Hon'ble President of India. It was also graced by Hon'ble Agriculture Minister Shri Sharad Pawar and attended by more than 250 national and international delegates.

The recommendations emerging out of the discussions held on above subject are given below:

Recommendations:

- Research in extension education should be based on appropriate sampling, quasi-experimental designs and statistical tools. The extension research findings should be utilized for agricultural research and development. There is a need to tap the large reservoir of farmers' tacit knowledge to consider their perspective and its blending with the scientific findings to develop applicable knowledge and appropriate technologies. The impact assessment of the technological interventions need to be analyzed and carried out with appropriate use of new tools focusing on profitability and livelihood security indicators rather than only yield data. Extension researcher should take care while inferring the meaning of results of adoption research so that effective communication and dissemination can be made. Future extension course curriculum should focus on comprehensive 'know how' and 'do how' of ICTs enabling future extension personnel to be e-ready. For all knowledge management initiatives, methodology for benchmark surveys and impact assessment need to be developed and standardized.
- In order to have appropriate convergence and integration of research, education and extension, the ICAR may specifically encourage SAUs and Deemed Universities (DUs)on this issue. The good extension models and best practices evolved and developed by various institutes and agricultural universities, which are found relevant in particular situations may be up-scaled by the main extension system responsible for large scale extension delivery. Integrated technology dissemination system (ITDS) combing all the available technologies from research institutes, extension organizations, input dealers, corporate R&D companies and marketing agencies need to be promoted for effective adoption of agriculture technologies and development of business models.
- The KVK- a unique intermediary institution created as part of NARS in India to assess, refine, demonstrate and function as knowledge and resource centre of agricultural technologies has emerged as a very successful model. This model may also be tried and tested in other developing countries as part of their NARS. Being the district level science based institution, KVK plays the role of knowledge and resource centre for better knowledge management, but expectations from KVK should be confined to mandated activities.
- All the extension/ KVK staff need to be provided with mobile phones and also there needs to be provision for funds for operational expenses. Mobile based advisory should be provided by district based institution (e.g.KVK/ ATMA etc.). To enhance the uses of ICT in agriculture, there is a need of

capacity building and training of users, KVK staff and farmers for exploiting the strength of ICT for extension purposes. The recommendations emerging from on-farm trials conducted through KVKs need to become part of package of practices of the district for smooth horizontal expansion of the technologies.

- Agricultural Technology Management Agency (ATMA) as a reform measure needs to be projected as an innovative institutional arrangement at district level and not as a scheme or project. Hence, regular interfaces with frontline systems are necessary to dispel any misconceptions about ATMA and its importance as mainstream extension interface at cutting edge level.
- Human resource development is critical to ensure transition of agricultural extension system for effective agricultural knowledge management. Hence, there has to be a serious re-look at the policy of restricted recruitments. This problem is alarmingly acute in allied sectors like animal husbandry, fisheries, horticulture, sericulture, etc. which have significant contribution to agricultural GDP. It is, therefore, strongly recommended for rigorous HRD, training and capacity building of all stakeholders.
- There is a need to promote transnational exchange of extension knowledge. When it comes to translate this imported knowledge into action, due care has to be exercised to test it for relevance, feasibility and profitability in terms of local conditions, and then adapt/adopt it. The implication is that one universal model fits all is not proper here and we need to explore the 'best fit model' in terms of the local adaptability.
- Entrepreneurial success depends on personal factors as well as external support systems. Hence, there is a need to strengthen the entrepreneurial attributes of farmers by capacity building and providing facilitative measures like credit, technical backstopping, policy support and sustained cooperation till they independently manage their enterprises, besides promoting entrepreneurship in value chains of livestock, fisheries, horticulture, apiculture, sericulture, etc.
- Amongst various options of capacity building, awareness generation, frontline demonstrations, vocational education and training programs and training/ retraining of extension education functionaries are advocated. Frontline demonstrations, which emphasized on 'learning by doing' and 'seeing is believing' for effective technology application are to be strengthened. Focus should also be made in print and electronic media.
- Open and distance learning is considered as the most viable means for broadening education access, while improving the quality of education, advocating peer-to-peer collaboration and giving the learners, a greater sense of autonomy and responsibility for learning. The learning system needs to be adapted along the way, according to the situation and the adaptation required in that particular situation. Vocational training should also be imparted by

the scientists on village and panchayat levels. Need based pre-service and in-service training programs, keeping in view their educational level need be incorporated as essential component of human resource development. Training needs to be promoted for increased knowledge of rural women to change their attitude to a significant level regarding value added products.

- In the context of climate change and other pressing agrarian challenges, ICT mediated knowledge management strategies should focus on improving the access to risk management knowledge products and advisory through mobile phones. It is recommended that extension systems have in place, capacity building of farmers and extension workers in optimum use of mobile networks. Most of the advisories being issued through mobile facility are text based. Text based advisory can be used only by literate farmers. The voice based SMS in vernacular language can be easily understood by illiterate farmers. There is a need for NARS to focus on application of sensor based networks for precision farming as there seems to be less focus in this direction. Low cost teleconferencing needs be encouraged to enhance the knowledge sharing and problem solving capabilities of extension personnel.
- Various content management tools used in different portals need to be adopted for extension systems. Knowledge Portals should be developed with vernacular language content to meet out local needs. There is a need to work on strategies for technologically empowering input dealers as that of MANAGE's initiative for agri-business. More focus should be given to farmers' success stories through print media and ICT tools. Market information systems should be integrated with KVK system so that knowledge is provided along with market information. Quality content creation at national level with active participation of concerned crop research institutions and experts (In-service and retired) needs to be done.
- Public-private partnership needs more emphasis in the process of agricultural knowledge management and the same should be a two-way process for accepting and sharing technologies. Extension through participatory approach needs to be holistic covering watershed development, technologies for higher productivity, increasing access to markets etc. Role of NGOs and cooperatives is significant in agricultural knowledge management and the same may be strengthened through effective convergence. Participatory irrigation management through group dynamics needs to be promoted at micro level. Concepts like village resource centre can be encouraged for agricultural knowledge sharing at grass root level. Strengthening of linkages between SHG's and different technical institutions and NGO's is important in the process of agricultural knowledge management.
- The successful networking approaches like Krishi Mahotsava, Community radio, Krishak Samithi, Samaj Shilpi Dampatti Model, Satellite approach and innovative mode of agro-advisory services need to be strengthened, process

documented and up scaled. Participatory approach for managing the knowledge may be more effective if the primary stakeholders, viz., the farmers may be successfully persuaded to share their part in terms of labor, partial operational cost, land and other requirements. Moreover, support for establishment and sustaining the farmers' club by related institutions shall further add to the success of participatory approach. Endogenous tourism needs greater attention by all the related partners/stake-holders for maintaining eco-sustainability in hill agro-ecosystem.

- Climate change is a broad based multidimensional issue. Prioritization of short- and long-term issues and goals for mitigation is necessary. There is urgent need for comprehensive study and systematizing the efforts in aggregating information on various aspects of climate change and its dissemination through development of a dedicated climate change portal. NRM and Extension Divisions of ICAR need to jointly organize a brainstorming session on climate change and agriculture. In view of climate change, the climate resilient technologies should be tested and refined with traditional knowledge systems for their dissemination. The technology modules being developed by Krishi Vigyan Kendras (KVKs) under National Initiative on Climate Resilience Agriculture (NICRA) should be replicated through convergence with line departments of State Governments.
- In order to conserve the natural resources, resource conservation technologies should be promoted on large scale focusing mainly the soil and water. For promotion of resource conservation technologies and also to save labor with economy, custom hiring services for farm implements and machinery at Panchayat level should be made available to the farmers. For increasing input-use efficiency with the objective of increasing factor productivity and profitability, appropriate technologies related to water and nutrient management should be popularized on large scale. In view of shrinking size of holding of the farm families, there should be ban on converting agricultural land to other purposes. Simultaneously, massive program should be launched for converting the degraded and wasteland into cultivable lands.
- In order to increase the profitability in farming and ensuring sustainable livelihood security to the marginal and small farmers, secondary agriculture should be emphasized and appropriate technologies for post-harvest and value addition to the produce should be made available to the farmers.
- Land consolidation should be given rethinking for promotion of mechanization and precision farming technologies. Land records of the farmers should be updated and made online and each and every farm family should be provided a land possession card. Capacity building program for agricultural laborers should be carried out in the field of improved agricultural technologies. Prices of agricultural commodities should be fixed keeping in view the regional realities and a Composite Input Cell Produce Procurement Centre should

be established at Panchayat level. In view of labor problem in agricultural activities, the provision of Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) should be extended to the agricultural activities.

- In place of "Research for Development" the concept of "Extension for Research and Development" should be made operational to address various current agrarian issues and agricultural knowledge management particularly in respect of emerging new risks in rainfed agriculture.

17. Farmer-led Innovations

(A National Workshop: December 23-24, 2011)

Background:

For centuries, farmers have been silently innovating and adopting various agricultural practices to make agriculture more efficient and cost effective. In particular, farm women have played a very important role in conservation of the germplasm and post-harvest management of crops. Somehow, most of these innovations by farmers have not been documented. Hence, they have remained un-noticed. This conference was specifically organized to assess the relevance of farmer-led innovations and the need for further validation and up-scaling of promising technologies for greater benefit to all stakeholders.

The workshop was organized by the Haryana Kisan Ayog, ICAR, TAAS, HAU, PPV&FRA and NIF and attended by 137 participants in which around 20 innovator farmers were specially invited. The discussions held during the workshop on 23-24

Inauguration of the Workshop by Chief Minister Shri Bhupinder Singh Hooda

December, 2011 at Haryana Agricultural University (HAU), Hisar resulted in the following important recommendations:

Recommendations:

- It is necessary to set up sanitary and phytosanitary and quality testing laboratories, preferably, in producing zone in each region to test and certify farm products (agri-products, organic foods, medicinal plants, dairy products, forest produce, etc.) produced by the local entrepreneurs for which Government, Private Sector and the NGOs support is critical and essential. (Action : SAUs, SDA)
- The available valuable knowledge relating to medicinal uses of local herbal plants need to be gathered and documented through appropriate incentive and reward mechanisms before the same is lost forever or remains unknown/hidden. For further strengthening of this area, there is a need to develop processing facilities for preparing primary products and drugs from locally available medicinal plants, especially to treat common ailments. Also, patenting and popularizing such value added products in the local markets will benefit both the producers and the consumers. (Action : SAUs, ICAR, NBPGR, PPV&FRA)
- The farmers' knowledge must be improved about non-traditional food crops having nutritional and medicinal values, such as Navara rice, minor millets and other high value low volume crops. Government should help such farmers in their capacity building and marketing of value added products. (Action : SAUs, ICAR, SDA)
- Elite germplasm and varieties identified by the farmers should be registered with NBPGR and PPV&FR Authority, respectively and required quantity of seeds may be deposited in the Gene Bank. The SAUs and ICAR must help the innovator farmers with the help of State Govt. in this endeavor. (Action: ICAR, SAUs, NBPGR, PPV&FRA)
- Farms of progressive farmers should be recognized as Centres of Excellence to facilitate the visits of other farmers. The services of farm innovators/ progressive farmers should be utilized as Professors, Experts, Krishi Pracharaks or Krishi Mitras by KVKs of ICAR and SAUs. (Action: ICAR, SAUs)
- The resource conservation technologies be demonstrated and refined at RRS/ KVKs and at the site of progressive farmers. Weed management research and technologies related to DSR should be strengthened by ICAR research institutes and SAU's to help the rice growers. (Action: SAU/ICAR)
- Good quality elite males of various indigenous breeds should be made available in the clusters of villages in order to establish profitable dairies/goatries/ piggeries. (Action: SDAH)
- Scientific livestock/ poultry/fish farming, and animal production and health related technology transfer to farmers needs to be taken up on a massive scale

for increasing livestock production and productivity in the State. (Action: SDAH; Director, Fisheries- Haryana and LLRUVAS)

- The machinery/equipment required for small dairy farm mechanization, primary level milk processing and value addition should be identified, tested, multiplied and made available to needy farmers on subsidized rate. (Action: SDAH)
- Currently, scattered extension and training programs are being organized by different government organizations and other agencies. There is need to establish workable linkage and centralized training complexes for women farmers and other entrepreneurs in each state. Extension approach needs to be strengthened and reoriented to make them more women friendly. (Action: State Govt., ICAR, SAU's)
- Policy for establishment of viable units of integrated farming system by combining need based location specific components of crops, vegetables/flowers, tree crops, livestock, fisheries, poultry, mushroom cultivation, vermicomposting, biogas units, etc. to train students, youths, women and other farmers at the HQs, RRS and KVKs for developing required skill and entrepreneurship. (Action: CCS HAU, LLRUVAS, ICAR and SDA).
- Policy initiatives are needed to support and encourage small cooperative societies, SHGs, farmer companies for production and multiplication of quality seeds, planting material and establishing value addition, processing and marketing and storage units of horticulture, dairy, fishery and other produce at production sites to help the farmers. (Action: State Govt.)
- "Village Farming Schools" should be opened at least at Panchayat level in Haryana and other States. (Action: State Govt.)
- There is need to develop women friendly technologies and disseminating already developed technologies with defined strategy, need-based training and financial support. In this context, the educational tours of interested women farmers to show the units of value added agri-products and farms of progressive and innovative farmers should be arranged on regular basis to encourage and help them to adopt such technologies. (Action: DAC with ATMA, SDA, Haryana; Director, Fisheries, Haryana, ICAR, SAU's)
- A regular mechanism for holding such workshops frequently in each state for scientist-farmer dialogue would certainly accelerate the process of agricultural innovations and hence, be put in place at the national level by the relevant organizations such as Division of Extension of ICAR by involving SAUs, TAAS, NIF, Farmers' Commission in different States, etc. (Action : ICAR)
- The innovations made by the farmers should also be protected for their intellectual property rights (IPR), for which SAUs/Kisan Ayog/Farmer Commissions should provide needed awareness, guidance, technical and financial inputs. (Action : SAUs, PPV&FRA, Farmer Commissions)

- Agro-tourism around farmers' innovative efforts would not only generate public awareness but will also help in revenue generation and greater community involvement in protecting our rich biodiversity. (Action : SAUs, SDA)
- Scientists-farmers interaction may be enhanced through appropriate mechanism so as to get the feedback for research system about the field performance of the technology as well as upscale farmer led innovations. (Action : ICAR, SAU)

18. Women in Agriculture

(A Global Conference : March 13-15, 2012)

Background:

Empowerment of women is a pre-requisite for inclusive growth. Realizing this fact, the Global Conference on Agricultural Research for Development (GCARD) 2010 emphasized specifically on the need to empower women producers being central to agricultural research and rural development processes. It also urged all stakeholders to work jointly to reshape agricultural agenda so as to meet the needs of farm women for their increased efficiency and involvement in the farming operations as effective partners and decision makers.

To achieve these objectives, this conference was jointly organized by GFAR, APAARI, ICAR and TAAS from 13-15 March, 2012 at NASC Complex, DPS Marg, New Delhi. It was inaugurated by Chief Minister of Delhi Mrs. Shiela Dixit and the Plenary Session was attended by Hon'ble President of India Mrs. Pratibha Patil.

Inauguration by Hon'ble Chief Minister of Delhi, Smt. Sheela Dixit

Shri Sharad Pawar, Agriculture Minister honouring H.E. The President of India

Innovation Market Place

Progressive women farmers with certificates given by Dr. Mark Holderness, GFAR

Display of products at Market Place

The conference was well attended by 760 participants. A large number of women experts (around 150) from over 37 countries deliberated on the critical issues impacting women's involvement in agriculture and came out with the following recommendations:

Recommendations:

- As a first step in empowering the gender role in agriculture, we urgently need to generate, document and share country specific gender disaggregated data on the contribution of farm women, existing gender disparities and the success of on-going development programs in addressing gender related concerns.
- There are strong linkages among agriculture, nutrition and empowerment of women, which need to be fully acknowledged while addressing the concerns of gender disparity. Control of women over household income is invariably linked with improved nutrition, health and education of children. Therefore, efforts are needed to harness the socio-economic benefits. These should

entail: (a) improving effectiveness of government investments by making them gender sensitive and through effective participation of rural women in prioritization and monitoring, (b) building capacity of women community groups for creating awareness, asserting their rights, articulating their needs and enhanced role in program planning, implementation, monitoring, and (c) enhanced role of scientific institutions in production of nutrition rich food and better post-harvest processing and value addition.

- Since nutritional insecurity is a complex issue and involves a multi-sectoral agenda, straight jacketed solutions may not always yield sustainable solutions. While it is important to define more comprehensive indicators for measuring household nutrition security, the organizations associated with nutrition and women empowerment should form a 'nutrition umbrella base,' which can help develop an integrated strategy for greater effectiveness. These efforts should be supplemented by those of micro-enterprises and women self-help groups for production and distribution of nutrition rich foods. The researchers should develop and use better methodology to generate required evidence and databases on the status of malnutrition and multiple pathways leading to nutritional security.
- In order to address such a complex issue as gender, individual and isolated line of action would not mean much. Hence, efforts should be made to build and strengthen coalitions by providing an enabling environment for the development of innovative networks (that breakdown silos between stakeholders, institutions, sectors and disciplines) and partnerships involving public and private sector, civil society, grassroots organizations, and bilateral and multilateral development organizations. Such networks can be developed at the regional, national and local levels, and can help generate credible evidence on economic and social impacts especially when role of women is not included in the development process.
- One of the most significant socioeconomic changes taking place in the developing countries during the last decade or so is the phenomenal growth of women SHGs that promise to play a pivotal role in the empowerment of women and transformation of rural areas. Hence, this is the time when we harness full potential of these SHGs by supporting fully the capacity building and leadership development initiatives. Channelizing agricultural support services such as extension, information, credit, inputs, marketing through these SHGs and providing them adequate resources for entrepreneurship development, through vocational training would help raise income of farm women. A special fund, 'Women Empowerment Fund' must be created at the national level to support gender specific welfare associated programs.
- A 'must do now' for all is to ensure effective control of women on productive assets and income is securing property rights like land rights for women.

This needs: (i) revisiting of laws on marriage and inheritance of property, and work on those which can be feasibly be amended and enforced; (ii) working with local and national governments to ensure secure land rights to women, (iii) recognition of customary systems, capacity building/education, and initiative of activities that lead scaling up (e.g., China's case for including women's names on ownership documents or inheritance through daughters as in the Philippines); and (iv) enforcement of laws to ensure women's access to and control over assets. These property rights should also be supplemented with building capacity and knowledge of women to take full benefits of these rights.

- Agricultural markets are also changing rapidly and women are at risk because of their limited access to markets and price volatility. The new business models focus more on financial viability and often ignore gender issues. As a result, women fail to take advantage of emerging market opportunities and remain mostly as wage earners or non-paid farm workers. Therefore, appropriate commodity based models such as "Mama Lus Frut Scheme" of New Papua Guinea should be promoted and women should be encouraged to become members of producers and marketing associations. These efforts should be backed by overall strategy to improve the market access through development of market infrastructure and better information flow by use of information communication technology (ICT).
- Agricultural research should be reoriented to make it more gender sensitive with emphasis on issues that lead to empowerment of farm women. Steps are required to induct more women scientists in the national agricultural research system (NARS) to enhance their role in policy, research planning and technology transfer. For this, there is a need to revisit agricultural education system and to revise course curricula to make it more gender sensitive. Also, emphasis on enhanced enrolment of girl students in agricultural universities will be desirable.
- AR4D systems have invariably come out with innovations which can increase work efficiency of women and reduce their drudgery in various farm operations. Some of these innovations must be out scaling for greater impact. Therefore, major efforts are needed for systematic documentation, dissemination, and adoption of relevant innovations. At the same time, efforts are needed to address safety, health and risk related issues concerning farm women so as to increase their efficiency.
- Climate change and weather related risks are likely to influence rural livelihoods and affect adversely the agricultural productivity. The strategy to deal with this challenge should also include assessing vulnerability of farm women to climate related risks, pathways to participate in the positive opportunities, if any, both for adaptation and mitigation options. Management of risk, access to technologies to make climate resilient agriculture, capacity

Dr. M.S. Swaminathan presenting a momento to Smt. Shobhana Narayan

Dr. R.S. Paroda was honoured for his contributions by delegation from Central Asia

building for anticipating the risk and its management through appropriate farm practices also deserve special attention. Climate change related policy such as REDD+ must have clear gender perspective and should encourage women participation both during planning and implementation stage. While providing compensation for environmental services, farm women should also be the beneficiary for their role.

- Gender issues are dynamic and so are both agricultural and socio-economic environment. This underscores the need for concerted efforts to understand diversity and severity of gender issues across the globe on a continuous basis. Researchers, policy makers, development agencies, regional and global fora, civil society organizations (CSOs) and women groups should come together to understand better the gender issues and share their experiences as to what works and what does not for the empowerment of women in agriculture. The global conference on women in agriculture (GCWA) has proved to be an important platform to meet these objectives. Therefore, this conference should henceforth be organized on regular basis once in every three years. Forum for Agricultural Research in Africa (FARA) readily agreed to host GCWA2 in Africa in 2015.
- Considering the urgency of addressing all gender related issues in agriculture across the world, a global partnership program called "Gender in Agriculture Partnership (GAP)" must be launched involving partnership of research and development organizations, national governments, regional and global fora, multilateral development agencies and donors. This platform should provide space for both policy research and policy advocacy on gender related issues in agriculture. GAP can also provide much needed technical backstopping and guide on future investments in programs relating to gender in agriculture. It will also facilitate effective networking and collaboration amongst active partners engaged in empowerment of farm women so as to attain desired inclusive growth in agriculture.

19. Foresight and Future Pathways of Agricultural Research through Youth

(A National Workshop: March 1-2. 2013)

Background:

Nearly 35 per cent of Indian population is in the age groups of 20-35 years and among country's agricultural scientists 27 per cent are below the age of 40 years. Enhancing knowledge and skill of these scientists demands an integrated approach to research themes to produce competent professionals. The workshop focused on ways to engage young agricultural professionals into cutting edge goals set for agricultural development critical for our country. The workshop was organized by ICAR, APAARI and TAAS on 1-2 March, 2013 at NASC Complex, DPS Marg, New Delhi. After in depth discussions on various aspects concerning involvement of youth in agriculture, the following recommendations were put forth by the participants:

Group photograph taken during the National Workshop

Recommendations:

Research

- There is an urgent need to reorient agricultural research towards farming systems' mode by ensuring inter-institutional and inter-disciplinary collaboration, and creating state-of-art research facilities
- For taking research to end users, greater emphasis is needed on joint research with the private sector through creation of excellent research infrastructure
- As a matter of institute level priority, there should be greater emphasis on collaborative research with advanced national/international research institutions

- To have a provision of a seed grant (Rs 10-15 lakhs) for each of the newly recruited scientists to encourage them to initiate research in a program mode rather than project mode
- Provision of a special project for young scientist to be made through competitive research at the national level by ICAR
- Encouraging young scientists for grant of patents and innovations
- Creating ICT facilities to discourage the repetitive research as well as for timely scientific accounting of the scientists

Development

- Short-to long-term trainings for young scientists at advanced research institutions at both national and international level
- Greater involvement of young scientists as members in decision making bodies at institute level such as RAC, SRC/IRC and academic council, etc
- Provision of training programs at NAARM for young and mid-carrier scientists for building scientific research leadership qualities
- Provision for institutional grant and administrative freedom to presentation of research work in International Conferences and its publication in referred journals

Policy

- Greater emphasis on human resource development through allocation of funds at institute level with more freedom and accountability
- Balancing the funding resources for basic, strategic, applied, anticipatory and participatory research
- More scientific and administrative freedom for research pursuits by young researchers using a bottom up approach
- Creating centralized research facilities to encourage greater scientific collaboration with the private sector
- Incentives and rewards for innovation and out scaling for impacts
- National HRD strategy to address the concerns of smallholders through reorienting R&D efforts towards farming systems

20. Achieving Inclusive Growth by Linking Farmers to Markets

(A Brainstorming : June 24, 2013)

Background:

More than 85 per cent of the farming population comprises smallholders who have less than 2 hectares land. The contributions of smallholder farmers towards

Prof. Abhijit Sen and Dr. William Dar Co-chairing the Inaugural Session

agricultural production is very significant. Thus, improving the livelihood opportunities of these farmers is very important.

In order to address this issue, a brainstorming workshop was organized jointly by TAAS, ICAR and ICRISAT on 24 June, 2013 at IARI, Pusa Campus, New Delhi. It was attended by 40 participants including Dr. William Dar, DG, ICRISAT, Prof. Abhijit Sen, Member, Planning Commission, Dr. Ashok Gulati, Chairman, Agricultural Costs and Price Commission and many distinguished economists. The workshop came out with following important recommendations based on intensive discussions:

Recommendations:

Policy

- There is considerable scope to improve market efficiencies, reduce price spread and raise producer share. This requires empowerment of farmers to harness market through policy reforms, institutional changes and knowledge sharing.
- Existing marketing regulations like Agricultural Produce Marketing Committee (APMC) Act require changes to offer freedom and better choice to farmers for sale of their produce. However, this may not happen automatically and requires action on several fronts like new institutions of farmers, increased private sector role in marketing, better infrastructure and commitment of State Government to protect interaction of producers (farmers) and consumers.

- New mechanisms like producer companies, self-help groups (SHGs), contract farming etc. have shown promising and beneficial effects in some segments of agriculture and in some pockets. Their up-scaling and replication is a real challenge. This requires a relook into these models so as to make them more farmer friendly. Documentation of success stories at regional, national and global level and conditions for their success need to be ensured though supportive policy environment.
- Private sector can play an important role in scaling up and scaling out so as to have win-win models of linking farmers to markets. The partnership between public and private sector can take many forms, e.g. marketing cooperatives; development of cold storages, etc. For building public-private partnership, the government should provide incentives, higher investments and needed infrastructure, besides stable policies for faster development of agribusiness.
- At the grass-root level, the government with the help of either farmers or NGOs should facilitate growth of farmers' cooperatives or associations or producer companies through handholding of farmer-members in terms of empowering them in business skills, capital investment and risk management.
- Provision of credit, associated with development of warehouse receipts system, is an important mechanism that offers farmers, producer organizations and traders access to secured and reliable storage, which provide them with documentary title to their produce and thus enable them to obtain finance. This will avoid forced sales and help farmers realize better prices. The system may also minimize storage losses, and bring in efficiency in trade, while enabling small farmers to participate in markets while managing market risks. This practice should be given full policy support for bringing small holders in its fold.
- Role of women and rural youth in linking farmers to market (LFM) will be of great advantage. We need to design women and youth centric programs for their active role in agri-food value chain and support them through all means. FDI, contract farming rules/ regulations be reviewed to ensure protection of interests of both parties.
- With regard to contract farming, there is an urgent need to have interface with the private sector and farmers so as to assess their needs and concerns to ensure an enabling environment for them to succeed.
- New and evolving market mechanism like virtual market should be tried on pilot basis in some areas and replicated based on success so achieved.
- A policy dialogue on linking farmers to markets should take place at the national level involving policy makers, senior officials of concerned Ministries, scientists and representatives of private sector, farmers, NGOs and IARCs.

21. Out scaling Farm Innovation

(A National Workshop : September 3-5, 2013)

Background:

Innovations made in different areas by farmers have contributed immensely to the development of agriculture. Most of these innovations, however, remain confined to the areas of their origin and never reach to the community of farmers to benefit from. Moreover, many times, they do not reach to a productive stage just because of their scientific validation and further refinement.

It was for this reason that a full scale National Workshop was organized by TAAS, ICAR and APAARI on 3-5 September, 2013 at Shinde Auditorium, NASC Complex, New Delhi involving 267 participants comprising farmers, scientists, entrepreneurs, NGOs and bankers to discuss various aspects concerning out scaling farm innovations for larger impact. The recommendations emerging out of the workshop are given below:

Recommendations:

Policy

- There is an urgent need for a paradigm shift in AR4D to address the needs of small farmers and place renewed emphasis on "Farmer First" through participatory approach, better knowledge sharing and enabling

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policy environment to ensure food and nutritional security on a sustainable basis.

- Out scaling of innovations based on their techno – economic feasibility, relevance and utility would be the key for inclusive growth of small farmers. Hence, identification of such innovations like happy seeder, laser leveler, zero-till drill, paddy transplanter, conservation agriculture, protected agriculture, new varieties/hybrids, etc. and their faster adoption or use will benefit considerably the small holder farmers.
- Mission mode programs on small farm mechanization, protected cultivation, low cost rural based agro-processing for value addition, livestock development, promotion of hybrid technology, micro-irrigation, etc. would go a long way in increasing both productivity and income of farmers. Hence, greater policy support for promotion of these innovations will be needed.
- Farmer-led innovations relating to new crops, new areas, new on-farm/off-farm based secondary agriculture, etc. must be identified, tested, refined and advocated for large scale adoption for greater benefit to our farming community. Some examples are: rabi maize in Eastern India, spring maize in northern region, summer mung in rice – wheat cropping system, boro rice in West Bengal, direct seeded basmati rice, vegetable production in plastic tunnels, polyhouses, micro-irrigation, fertigation, organic farming, etc.
- Integrated farming systems involving high value crops and livestock should be developed and encouraged for different agro-ecosystems. This would help in increasing income of small farmers.
- Market reforms should be given high priority for promoting farmer-led innovations. Revision of Agricultural Produce Marketing Committee (APMC) Act especially to delink horticultural produce (vegetables and fruits), provision of kisan bazars/ huts, cool chain and credit linked trade/marketing options, and linking farmers to markets will be required to benefit both farmers and consumers.
- Convergence and connectivity of different institutions and development programs for out scaling of innovations and development of necessary social skills is necessary. The innovations in use of renewable sources of energy, like bioenergy and solar energy should be improvised and out scaled by convergence of programs and activities of different government departments and private sector.
- Market innovations should ensure greater share of farmers in the transparency in price discovery, better delivery of quality inputs, flow of market information and risk management.
- For open access knowledge sharing, there is a need for more effective and rather efficient extension mechanisms like ICT, smart phones, radio and

television (dedicated channel exclusively on agriculture). Creation of a cadre of young technology agents for custom hire services in specialized areas will help in reducing dissemination losses while out-scaling farm innovations.

- Incentives and rewards to innovative farmers will be needed to promote useful technologies on farmers' fields. For this, central and state governments must create "Farm Innovation Fund" so as to ensure their sustained interest in creating and promoting new initiatives for enhanced productivity and income.
- Incentives and venture capital funds should also be provided to the entrepreneurs for up-scaling and out scaling farm innovations and technologies, which need substantial investment in producing material (planting material, machine, seed, feed, etc.) for out scaling the innovations.
- There is an urgent need to have institutional reforms especially for better coordination, convergence and efficiency. Linkage between KVK and ATMA, linking schemes under MNREGA, RKVY, NFSM etc. without scaling of useful farm innovations, each KVK to act as an ATIC, promotion of self-help groups (SHGs), establishing cooperatives and farmers' company, etc. will help in having greater impact of new innovations. Also, successful public-private-partnership models will have to be replicated by creating enabling policy environment.
- Innovator farmers so identified must be rewarded and given incentives, as well as, recognition as "Farm Professors", so as to share their knowledge and experience, while imparting training to others for much needed capacity development. Farmer to farmer training will have much greater acceptability and generate confidence for out scaling new innovations.
- Availability of credit at low interest rates and provision of insurance schemes for promotion of activities by SHGs, cooperatives, farmers, companies, especially for processing, grading, storage and primary value addition will encourage smallholder farmers in out scaling their innovations, since, such provisions will reduce risk factor and build much needed confidence to promote farm innovations.
- Farm innovations in livestock and other high value products are, rather, less documented and out scaled. There are many innovations relating to low cost medicinal and nutritional products in livestock sector. These need verification, improvement and out scaling.
- There is also a great need to provide adequate visibility to protection of farmers' innovations and sharing of benefits from their commercialization. These should go beyond plant varieties. Special programs must be supported to promote innovations in on-site conservation of genetic resources.

22. Strategy for Conservation and Productivity Enhancement of Farm Animal Genetic Resources

(A Brainstorming Workshop; January 10, 2014)

Background:

Animal husbandry is an integral component of Indian agriculture supporting livelihood of more than two-third of the rural population. Milk and milk products, eggs and meat among the livestock and poultry products are key contributors to achieving nutritional security. Other contributions from the sub-sector are; draught power, fuel, wool, fibre, manure, hides & skin, etc. It also offers income-generating opportunities through self employment. India has a rich genetic resource of farm animals, which includes 144 registered breeds of livestock and poultry (37 breeds of cattle, 13 of buffalo, 39 of sheep, 23 of goat, 6 of horse and ponies, 8 of camel, 2 of pig, 1 of donkey and 15 of poultry). In addition, there are many undescript/unregistered populations of other animal species like mule, yak, mithun, duck, quail, etc.

Small scale livestock keepers and pastoralists have developed locally suited, resilient animal populations over the centuries. These animals have been deeply integrated with their economy, cultural values and knowledge system. Further, evolution of intensive livestock production and market demand had promoted use of few specialized breeds with specific production traits. This process resulted into loss of genetic variability of native breeds. Declining livestock diversity has adversely affected our capacity to potentially mitigate the challenges posed by climate change as well as emerging diseases. Some programs have been initiated in last two decades to address the decline in indigenous livestock and poultry wealth. Still, there are wide gaps in terms of legislative, policy and administrative measures besides the

Group photograph of the delegates

required level of coordination among various agencies/stakeholders as well as proper execution of breed improvement and conservation programmes.

Considering the importance of issues related to breeding strategies and conservation of Indian farm animal genetic resources, TAAS organized a brainstorming workshop jointly with the Indian Council of Agricultural Research (ICAR), and the Department of Animal Husbandry, Dairying & Fisheries (DAHD&F), Government of India in New Delhi on January 10, 2014. More than 100 participants, including policy makers, researchers, senior officers from Central and State Animal Husbandry Departments, field officers, NGOs, livestock keepers and experts in the field of animal breeding and conservation attended this interface workshop. The following recommendations emerged from the workshop:

Recommendations:

- Considering the urgency, a time bound National Action Plan must be finalized and put to action as a National priority for conservation and management of the existing rich diversity of valuable indigenous livestock genetic resources.
- To begin with, each State must at least identify and declare one livestock breed as "STATE BREED" in order to initiate required conservation and genetic improvement activities on priority by creating the best possible facilities and to ensure participation of all stakeholders.
- A National Livestock Development Authority be established by DAHD&F especially for the breed conservation and management programs. A possible composition of the National Authority could be :
  - Secretary, DAHD&F - Chairman
  - Deputy Director General (Animal Sciences), ICAR
  - Director, NBAGR
  - A few (3-4) Directors/Chief Executive Officers of SAHDs
  - Two representatives from NGOs/*Goshalas*
  - Animal Husbandry Commissioner - Member Secretary
- In order to protect the rights of Livestock Keepers and to ensure proper access and benefit sharing (ABS) of AnGR, a legislation similar to the Protection of Plant Varieties and Farmers Rights Act (PPV&FRA), should be drafted and proposed jointly by NBAGR/ ICAR and DAHD&F for speedy approval of its enactment. This recommendation was reiterated from the "Ranchi Declaration".
- A National Gene Fund linked to National Livestock Mission should be created soon by the DAHD&F so as to ensure effective implementation of specific breed conservation programs. In this context, efforts be directed to implement "Ranchi Declaration" as a national priority.

- NBAGR must accelerate the pace for characterization, documentation and registration of different livestock and poultry strains/breeds by further strengthening the Network Project on Animal Genetic Resources, involving all relevant institutions/organizations and by assigning breed specific responsibilities.
- An online Information System for management of data on animal genetic resources of the country should be developed at the National level and each state should identify a nodal officer responsible for regular updation of data, on a pattern similar to that of Domestic Animal Diversity Information System (DAD-IS) model of the FAO.
- NBAGR, in collaboration with DAHD&F, should organize regular public awareness/sensitization programs in various States for understanding of the importance and utility of our available animal genetic resources in the country.
- The State Animal Husbandry Departments (SAHDs) must ensure sufficient quantities of semen doses of superior germplasm/males to help implement a national breeding strategy.
- All SAHDs need to promote the establishment of animal breed societies and initiate performance recording of important indigenous breeds at field level in order to ensure effective bull evaluation.
- There is an urgent need to develop niche markets for breed specific value added products for conservation through improvement and use of indigenous farm animal breeds.
- Some Goshalas hold sizable population and infrastructure, which could be used for genetic improvement of indigenous breeds as well as their *in situ* conservation. For this, Government must provide the needed support, and technical backstopping be extended by the State Agricultural Universities (SAUs) and ICAR institutes.

23. Soybean for Household Food and Nutrition Security

(A Brainstorming Workshop: March 21-22, 2014)

Background:

One of the major challenges of Indian agriculture currently is to ensure household nutritional security for the vast (40%) vegetarian population of India which depends largely on pulses for meeting its protein requirement. But, pulses are very costly as our indigenous production is too less and in order to meet our requirement large quantity of pulses have to be imported. Interestingly, protein from soybean is inexpensive and provides better protein than pulses. However, soybean is not very popular among masses.

Dr R.S. Paroda delivering his address

This workshop was organized by TAAS, ICAR and NAAS on 21-22 March, 2014 at NASC Complex, DPS Marg, New Delhi. It was attended by 78 experts to explore possibilities of exploiting and promoting soybean as a food crop being an important source of protein to address the problem of malnourished children whose number is around 200 million currently in India. The main recommendations emerging from this interesting brainstorming workshop are given below:

Dr R. Chidambaram at display of soya products

Recommendations:

General

- Soybean is a treasure trove of nutrients. Therefore, use of soybean as human food needs to be promoted through appropriate policy interventions and public awareness initiatives. A mission mode project in this regard is fully justified at the national level.
- Soybean is a crop of considerable importance to India. Its production has to be increased to ensure household nutritional security. Fortunately, India can double its soybean production in the next decade, provided area is increased under assured irrigation both in the north and north-eastern region. What is needed is varietal diversification and good agricultural practices, including higher seed replacement rate, effective weed management, on-farm mechanization, ridge furrow planting, supplemental irrigation (1-2) and intercropping.
- Use of full-fat-soy-flour in Indian diets at 10 per cent level is already an accepted policy. Hence, fortified flour and other soy-products need to be promoted further under food product category by the Food Safety

and Standards Authority of India (FSSAI). Further, these soy-products be considered as essential food items and be kept out of taxation network as a national policy.

- Protein-rich soymeal also needs to be promoted for local consumption as feed for fish and livestock in order to increase their productivity and increased income of resource poor farmers, especially in arid areas. A brainstorming session in this regard could, hence, be organized involving all stakeholders to decide future road map.
- Public-Private Partnership (PPP) has to be strengthened to promote small scale entrepreneurship, contract farming, licensing of new innovations and soy product development etc.
- Krishi Vigyan Kendra (KVK) of ICAR, Home Science Colleges under SAUs, and some research institutions under CSIR, ICAR etc. are engaged in promoting use of various soy-products as human food. These initiatives need to be strengthened under the proposed Mission on Soybean.

Research

- Urgent initiative is needed to widen the genetic base of soybean, which is currently quite narrow. We need to exploit the untapped genetic potential, especially the wild and perennial gene pool, for higher productivity. Concerted efforts are, therefore, needed to introduce germplasm from China, South East Asian countries, USA, Brazil, Argentina as well as from IITA, AVRDC, University of Illinois, etc.
- Research efforts need to be concentrated to develop soybean hybrids with wide adaptability and enhanced productivity. Similarly, research efforts need to be intensified in the field of genomics, Marker assisted selection (MAS) and also GM soybean, especially for ensuring effective weed management, abiotic and biotic stresses as well as to attain higher yields.
- Development and dissemination of rural based, low cost soybean processing technologies need to be promoted and popularized.
- To intensify research in soybean, a Centre of Excellence must be created immediately by the ICAR at Central Institute of Agricultural Engineering (CIAE), especially to develop the new products and to provide training to small scale entrepreneurs.

Policy

- For ensuring required coordination and addressing the problems of soybean growers, processors and consumers, a single window system through establishment of a regulatory board, namely, "Soybean Development Board" needs to be ensured on priority by the Government.

- Invariably, the existing trade and pricing policies are not favorable to soybean producers in India. Hence, there is a strong case to raise tariff on import of crude soybean oil from present 2.5 to around 10.0 per cent. Similarly, minimum support price (MSP) of soybean be raised to a level that is comparable to the market price and its procurement be ensured especially in new areas as northern and eastern India. Also, while introducing soybean in rice-wheat production system, linkage with processing industry be established.
- Tax incentives as well as tax holiday be given to soy-based industries, especially for establishing and expanding its use in non-conventional soybean growing areas. At the same time, a separate food product category by the Food Safety and Standard Authority of India (FSSAI) for all soy-based products be established. Also, soybean must be exempted from all central and state level taxes and duties, in order to make it abundantly available to the consumers to combat existing protein malnutrition in India.
- Though soybean is currently a rainfed (90%) crop in India, it offers good opportunities for doubling the production through productivity enhancement provided one or two supplemental irrigations are ensured. Hence, the rainfed tag on soybean has to be removed and it be popularized also in the irrigated areas, especially, for the diversification of rice-wheat production system in the Indo-Gangetic Plains. Soybean can favorably compete with rice if its productivity can be ensured around 2.5-3.0 t/ha, which is technically feasible.
- Soybean and processed soy-products (full-fat, defatted soy-flour, dal analogue, textured soy chunks etc.) need to be included in the nutrition intervention programs of the Central and State Governments such as mid-day meals, ICDS, military, para military, jails, Govt hospitals etc. so as to provide low cost, high quality protein to the resource poor consumers. Also, the soy-fortified wheat flour be made available through PDS and open markets to promote its use for household nutrition security.
- India is exporting currently around 5.5 mt of protein-rich high quality soymeal annually @ Rs 70/kg protein while importing pulses @ Rs 360/kg protein. Therefore, to fight protein-calorie-malnutrition, which is predominantly high in India, the export of soymeal be rationalized to maintain a balance between internal demand and existing export potential, for which though there is good scope as soymeal from India is all non-GMO.
- A compensation package, such as, nutrient subsidy equivalent for its high protein content and the nitrogen fixation in the soil be made available to the soybean growers. This along with high MSP, linked with procurement, both by Government and private sector, would accelerate higher growth of soybean production in India, for which there exists good scope.

- More investment for soybean R&D (at least three times) is needed urgently to harness full benefits by soybean growers as well as consumers. Also, higher investments on human resource development, involving all stakeholders, would go a long way, in addressing household nutritional security through use of soybean as a food crop in India.

24. Upscaling Quality Protein Maize for Nutrition Security

(A Brainstorming Workshop: May 20-21, 2015)

Background:

Inaugural Session of the Brainstorming Workshop

The Brainstorming Workshop on "Up-scaling Quality Protein Maize (QPM) for Nutritional Security" was organized jointly by the Trust for Advancement of Agricultural Sciences (TAAS), Indian Council of Agricultural Research (ICAR), Indian Institute of Maize Research (IIMR), National Academy of Agricultural Sciences (NAAS), International Maize and Wheat Improvement Center (CIMMYT), Borlaug Institute for South Asia (BISA), and the Indian Society of Genetics and Plant Breeding (ISGPB), at New Delhi on 20-21 May, 2015.

The goal of the Workshop was to review the progress and identify opportunities for enhancing nutritional security in India using Quality Protein Maize (QPM). The objectives were to assess the needs of stakeholders for enhancing QPM maize production and productivity; share experiences of success stories of QPM and other biofortified maize cultivars; create awareness of nutritional benefits of QPM among farmers, consumers and industries; strategize the research efforts for accelerated development of micronutrient enriched QPM and value-added processed foods, build effective networking and a framework for policy interventions to promote QPM.

The Workshop was attended by more than 100 participants, including government representatives, policy makers, scientists from the National Agricultural Research System (NARS) and international research organizations, public and private seed agencies, processing industry, progressive farmers and NGOs.

Group photograph of the participants

Dr. S. Ayyappan, Director General, Indian Council of Agricultural Research (ICAR) & Secretary, Department of Agricultural Research and Education (DARE), Government of India inaugurated the workshop which was presided over by Dr. Raj Paroda, Chairman, TAAS. Dr. S.K. Vasal, Former Distinguished Scientist, CIMMYT and the recipient of World Food Prize for his pioneering work on QPM gave special remarks on the occasion.

Preamble:

Maize has emerged as one of the most important crops as food, feed and industrial applications. Together with rice and wheat, maize provides at least 30% of the food calories to more than 4.5 billion people in 94 developing countries. Maize alone contributes over 20% of total calories in human diets in 21 countries, and over 30% in 12 countries that are home to a total of more than 310 million people. Globally, maize is cultivated in 184 m ha with a global production of 1016 m tons. Asia produces 304 m tonnes of maize from 59 million hectares. During 2013-14, India produced 24.35 m tons of maize from nearly 9 m ha. 23% of the maize produce in India is used for human food, while nearly 63% is utilized for poultry- and animal-feed. Between now and 2050, the demand for maize in the developing world will double, as the current global population of seven billion is likely to cross nine billion by 2050.

As per Food and Agriculture Organization (FAO) of the UN, India is home to 194.6 million undernourished people, the highest in the world. This translates into over 15 per cent of India's population, of which ~42% of children (<3 years old) are underweight and 58% of them are stunted by two years of age. The challenge

is, therefore, to deliver nutritious, safe and affordable food to an ever-increasing population in the coming decades to eliminate food and nutritional insecurity.

Quality Protein Maize (QPM), by virtue of its 2-3-fold higher lysine and tryptophan compared and enhanced protein quality over conventional maize, holds immense promise for alleviating protein malnutrition. Also, due to its higher biological value, balanced nitrogen index and leucine-isoleucine ratio, QPM offers significant nutritional benefits, which were well-demonstrated worldwide, both in terms of human food and animal feed. An array of QPM varieties has been released in sub-Saharan Africa, Latin America and Asia over the last three decades. India released its first generation of soft endosperm-based nutritious maize composites, viz., 'Shakti', 'Rattan' and 'Protina', way back in 1970. In 1997, the first hard endosperm QPM composite, Shakti-1, was released. The first QPM hybrid, 'Shaktiman-1' was released in 2001. So far, a dozen QPM hybrids have been released in India with wider adaptability to different agro-ecologies.

Despite the well-established nutritional benefits and varietal releases worldwide since last 3-4 decades, widespread cultivation and use of QPM as food and feed remains elusive. Of the 90 million hectares of maize grown in Mexico, Central America, sub-Saharan Africa, and Asia, only an estimated 1 per cent or less is QPM. In India, the area under QPM cultivation is negligible, as compared to the conventional maize.

The Workshop provided a platform to discuss in depth specific constraints/ bottlenecks in QPM value chain, and opportunities for up-scaling QPM production and utilization in India for enhanced nutritional security. The Workshop was structured in two plenary sessions, and six technical sessions, focusing on various aspects of QPM R&D, including: (a) staple food; (b) feed; (c) seed production and delivery; (d) policy support for promotion; (e) post-harvest processing and value addition; and (f) breeding challenges and opportunities. Salient recommendations that emerged out of these discussions are presented below.

Recommendations:

- The workshop participants unanimously agreed that QPM maize has great potential to address a major challenge of malnutrition being faced by large number of people in India (around 180 million), 43 per cent of whom are children below 5 years of age. QPM innovation, therefore, needs to be out scaled to ensure household nutrition security. For this, required public awareness to make maize an important food crop, instead of its current use as feed, would require urgent research, development and policy interventions in a mission mode approach.

QPM-based Food

- To harness full potential of QPM, there is an urgent need to sensitize the

processing and value-addition industry in India on nutritional benefits of QPM, so as to generate and deploy QPM-based value-added food products in both rural and urban markets. Village-level entrepreneurships and community-based QPM processing units (incentivized by Gram Panchayats) should be established for promoting QPM consumption in rural India. QPM-based products, such as QPM corn flakes, snack items, and QPM-fortified multi-grain 'atta' can be effective in reaching the health-conscious urban population. Proper labeling, suitable branding (e.g., Nutri-maize) and aggressive promotion would attract consumers towards QPM-based products.

- For effectively meeting the demand of the processing and value-addition industry, QPM varieties should be systematically evaluated for basic food quality parameters (industry-provided check-list) required for manufacturing specific products. Once suitable varieties are identified, continuous supply of QPM grains for the industry needs to be ensured through effective backward linkages; contract farming and 'buy-back' policy could ensure sustainable supply of quality QPM maize.
- 'Nixtamalization' is an important technological intervention that improves shelf-life of maize in general, including QPM, and it also helps in preventing aflatoxin contamination of stored products. This is being extensively used in Mexico, where maize is a staple food and hence could be introduced in India.

QPM as Feed

- India is the fifth largest poultry producer and third largest egg producer, with enormous growth potential (more than 10% per annum). The potential of QPM, especially yellow QPM, in strengthening the maize-poultry value chain needs to be effectively exploited. This will require awareness generation among the poultry industry about the nutritional benefits of QPM. A special workshop on "QPM Specialists-Poultry Sector Interface" should be organized for making the poultry industry aware of the benefits of QPM over conventional maize, and for devising a Road Map for promoting the use of QPM in poultry sector.
- Synthetic lysine is presently available at relatively cheap price to the poultry industry. Therefore, proposition of incorporating high-lysine QPM in poultry feed may look less appealing, given the fact that QPM grain is expected to be costlier than conventional maize requiring isolation distance for its seed production, besides need for market segregation. Therefore, it is critical to communicate the beneficial effects of tryptophan, which is high in the QPM maize. Tryptophan helps in regulating egg laying. Hence, benefits of availability of enhanced tryptophan in QPM grain should be compared vis-à-vis other sources of tryptophan in the feed, like soy meal, to demonstrate comparative advantages of QPM.

- To enhance the use of QPM in the poultry and livestock industry, research needs to be undertaken on:
  - The cost-benefit ratio to determine the value gained in terms of kilograms of meat or number of eggs by using QPM over conventional maize.
  - Understanding better the nutritional benefits of QPM (over conventional maize) on the quality of meat and eggs; this is required for creating specialized markets for more nutritious meat and eggs. So far, studies have focused only on the weight gain attributes of QPM feed over conventional maize feed.
  - The interface between QPM breeders and the poultry industry needs to be strengthened to understand better the trait and product preferences of the clients, and to reorient the breeding programs based on such feedback; for instance, recent studies have shown strong interest of the poultry industry in India in traits such as high methionine, provitamin A and high oil content.

Developing New QPM Varieties for Needed Impact

- To derive genetically diverse, high-yielding and climate-resilient QPM varieties that meet the requirements of stakeholders, QPM breeding program in India must be significantly strengthened, including selections from elite conventional × QPM crosses to generate new improved QPM inbreds; creation of new QPM synthetics/pools (with an understanding of heterotic groups) for extracting novel QPM inbreds with biotic and abiotic stress resilience; and diversifying the QPM germplasm base.
- As a short-term goal, fast-track conversion of some of the most popular and widely-grown conventional maize hybrids to QPM versions through marker-assisted selection (MAS) and doubled haploid (DH) technique, is the best possible option to develop QPM hybrids with wider adoption and acceptability. As a part of this strategy, the possibility of converting some popular private-sector maize hybrids into QPM versions through public-private partnerships, and introducing these QPM hybrids in the market needs to be immediately explored as this will significantly strengthen the QPM supply chain for the processing industry.
- More than 150 single-cross maize hybrids have been released so far by public and private sector organizations in India. These hybrids in particular have helped in doubling the maize production over last one decade in the country. While hybrids are adopted in ~60-65% of the maize-growing areas, ~35-40% of the area, especially in the tribal regions and North-Eastern states, is still under low-yielding landraces, local varieties and composites. Incidentally, these are also the areas where maize is a staple food. Hence, as an alternate strategy, the possibility of developing and deploying improved

QPM synthetics as well as low-cost, affordable maize hybrids, with higher grain yields and quality, needs to be actively explored.

- A Mission-Mode Project on developing the next-generation biofortified maize varieties (QPM, provitamin A, kernel zinc etc.), should be initiated immediately with strong emphasis on multi-disciplinary and inter-institutional partnerships. This project having immense potential to contribute to nutritional security in India must receive required funding support through agencies such as the National Agricultural Science Fund (NASF) of the ICAR.
- 'Nutritional Quality Service Labs' must be set up for strengthening the breeding programs for biofortified crop varieties, such as QPM. Capacity development programs at the accredited nutritional quality labs will help in building skilled manpower needed urgently for QPM research and development in India.
- Nutritional quality traits, such as enhanced lysine and tryptophan in QPM, are "invisible" traits. Farmers, thus, would face obvious difficulty in convincing the traders regarding better quality of produce while selling in the market. Development, validation and deployment of a low-cost portable device that rapidly determines the amino-acid quality of the maize produce (through quantitative estimation) would be of great help to the farmers. Brix meter is one such example, where sugar concentration in sweet corn is analyzed rapidly.

Seed Production and Delivery

- "QPM Seed Villages", with "One QPM hybrid-One village approach", must be established for community-based production of quality seed, through active engagement and training of progressive farmers. QPM Seed Villages should be particularly targeted in Tamil Nadu, Karnataka, eastern Uttar Pradesh, Rajasthan, Bihar and West Bengal, where opportunities for marketing (e.g., poultry/feed industry) exist. This will also help in reducing the cost of transportation as well as ensure timely availability of quality QPM seed to the industry.

Public-Private Partnerships

- Strong and active engagement of private sector in QPM R&D in India is important for up-scaling QPM adoption and utilization. Private sector seed companies with significant maize breeding, seed production and distribution network capacity in India should take up QPM development and delivery in the target markets. The 'Agri-Innovate-India' should play an important role in this regard. Government programs such as NSFM must support QPM seed production, irrespective of whether by public or private sector.
- Public-private partnerships for QPM research, based on mutual trust, focused objectives, respect for each other's intellectual property, and ABS (access and

benefit sharing) should be encouraged by providing an enabling environment by the Government. Bottlenecks, if any, with regard to effective exchange of germplasm / breeding materials between public and private sectors must be explored through an agreed material transfer agreement (MTA).

Awareness Generation and Enabling Policies

- Lack of adequate awareness among consumers is one of the major reasons for the poor demand for QPM. Intensive awareness campaigns, supported well by the Government, must be taken up to popularize the nutritional value of QPM and for enhancing its demand for consumption as food at the household level. QPM can potentially contribute significantly towards nutritional security, especially in the North-Eastern states and the tribal areas in India.
- In view of its potential benefits to the household nutritional security, QPM must be considered for inclusion in the 'rural transformation' project under NITI AAYOG. QPM should also be an integral component of the Government-sponsored agricultural development programs like National Food Security Mission (NFSM) and Rashtriya Krishi Vikas Yojna (RKVY), as well as the nutrition intervention programs, such as 'Integrated Child Development Scheme' (ICDS) and 'Mid-day Meal Program'.
- QPM requires policy support during the initial stages of takeoff in the form of seed kits, extension, and market support. QPM should also be supported through Market Intervention Scheme in the states where farm harvest prices are below MSP. Processing industry should also be incentivized to use QPM in various food and feed formulations.

5 Foundation Day Lectures/Special Lectures

TAAS has been organizing the Foundation Day Lectures and also the Special Lectures of eminent experts/research leaders on topics of current interest mainly at Dr.B.P.Pal Auditorium, IARI, New Delhi. Full house participation of more than 300 senior research scientists, policy makers, ICAR officials and especially the Post-Graduate students of IARI has been ensured in order to disseminate the best benefits and up-dates on various subjects/ topics of considerable national/ global interest.

In this context, TAAS has so far organized twelve such lectures (Annexure 6), which have also been printed and distributed widely. Following part provides the title and a brief description of all lectures organized, whereas all detailed papers are available on TAAS website (www.taas.in).

A. Foundation Day Lectures

Lecture 1 on Regulatory Measures for Utilizing Biotechnological Developments in Different Countries

The first Foundation Day Lecture was delivered on October 17, 2003 by Dr. Manju Sharma, Secretary, Department of Biotechnology, Ministry of Science and Technology, President, National Academy of Sciences, Allahabad; and the former General President of the Indian Science Congress Association. She has been associated with promotion, development, identification and monitoring of research and product development.

1st Foundation Day Lecture delivered by Dr. Manju Sharma

The learned speaker discussed different facets of biotechnology and biosafety and enumerated various mechanisms of risk assessment.

She emphasized that genetically modified organisms (GMOs) fall into two categories i.e. contained use and field release. Their use in agriculture involves exposure of the ecosystem. This continues to raise questions of adverse impact on non-target species and stability of the inserted gene.

To address these concerns, biosafety regulations have been developed by many countries. The most ambitious attempt to produce a globally harmonized regime for the biosafety has been under the Convention on Biological Diversity (CBD). The protocol seeks to protect biological diversity from the potential risks posed by living modified organisms. India is a party to the CBD and signatory to Cartagena Protocol on Biosafety. All countries are not party to this convention. Different counties follow different norms.

There are Latin American, African and South East Asian countries where the biosafety measures are not yet adequate. These disparities in overall policy and capacities amongst countries have profound cross border influence in terms of trade and commerce.

Keeping in view the accelerated growth of biotechnology and its potential applications, Government of India has evolved a regulatory mechanism for development, evaluation and release of biotechnology products. These rules and regulations cover all the areas of research as well as large-scale applications and release of GMOs and products thereof throughout India. To facilitate adherence of Rules, the Department of Biotechnology has evolved Recombinant DNA Safety Guidelines (1990). Apart from these guidelines, the Government of India has also amended relevant acts and rules to facilitate the development and release of GMOs and products thereof into the environment. Most of the regulatory systems are relatively open and transparent with precautionary approach, and are in general, compliance friendly. It is important to update mechanisms to meet the current challenges of the society based on the scientific knowledge which is growing phenomenally world over.

There are concerns in the society about both the advantages and risks of this emerging field of biotechnology. With proper scientific explanations, these have been adequately addressed.

Dr. H.K. Jain offering his comments

In agriculture, biotechnology research is crucial for enhancing productivity and quality including value addition and nutritional enhancement of the crop. Recombinant DNA technology has enabled scientists to genetically modify plants, animals, and microorganisms. Modern genetic engineering techniques can facilitate introduction of a greater diversity of genes into organisms – including those from unrelated species – than traditional methods of breeding. Thus, plant biotechnology is an extension of traditional plant breeding. However, there are also concerns regarding possible risks and hazards arising from the use of GMOs and products there from. The two main areas of concern are the impact on environment and ecosystem and the effects on human health. Immediately after the advent of rDNA technology, discussions began about the risks emanating from recombinant DNA experiments. In 1975, at an international gathering of scientists in Asilomar, California, the first set of recommendations to manage the safety of recombinant DNA experiments were formulated which formed the basis of subsequent biosafety regulations. In view of the fact that these organisms and products would be released into the market and would be widely used, the scope of evaluation of possible risks widened. These risks are classified as follows:

- For animal and human health: toxicity and allergenicity
- For environment: generation of new live viruses by recombination (trans-capsidation, complementation, etc.)
- For agriculture: resistance/tolerance of target organisms; alteration of nutritional value; susceptibility of non target organisms; evolution of super-weeds; instability of transgene; higher cost of agriculture etc.

Lecture 2 on Public-Private Partnership in Agricultural Biotechnology

The Second Foundation Day Lecture was delivered on October 17, 2005 by Dr. G.S. Khush, Former, Head of the Division of Plant Breeding, Genetics and Biochemistry, International Rice Research Institute, Manila. Dr. Khush, along with his team has developed more than 300 new rice varieties, some of which triggered Green Revolution in Asia in the 1960s.

Dr. G.S. Khush delivering the 2nd Foundation Day Lecture

Scientific advances in plant breeding led to "Green Revolution" regarded as the most important agricultural achievement of humankind. Food grain production in India doubled in a short span of 25 years between 1970 and 1995. While we should be proud of these achievements, we should not become complacent. Our population is increasing at the rate of 1.9 per cent per year. We are adding

Dignitaries on the Dias

19-20 million new mouths to feed every year. To meet this increase in demand, we will have to increase food grain production by 50 per cent in 2030 when our population is likely to stabilize.

Time tested methods of classical breeding such as hybridization and selection, ideotype breeding and hybrid variety development will continue to be used but tools of biotechnology will play increasingly important role in crop improvement.

Both the public and private organizations have important roles to play in harnessing the benefits of biotechnology and emerging field of genomics. Collaboration between the two sectors is even more crucial for addressing the problems of food security and poverty alleviation in developing countries. Several examples of public-private collaboration and partnership were put forth in this lecture which showed that large life science companies such as Monsanto, Syngenta, Pioneer are willing to donate their proprietary technologies (genes, promoters, processes and sequences) for humanitarian causes.

In addition, the formation of global public-private alliances and international agreements will be critical to ensure that the current explosion in genomics knowledge is tapped to solve the problems of poor producers and consumers. The public sector has critical assets in the form of germplasm and associated biological knowledge important in new science of genomics. However, to fully exploit these assets, public sector must develop a capacity in IP management, strengthen biosafety protocols and upgrade business skills. Most public-private alliances to-date are been based on free access to proprietary technologies for non-competing markets.

Market segmentation is likely to be a key element in public-private negotiations in the future. To ensure that public sector organizations in poor developing countries have access to proprietary technologies, multinational life science companies should have enlightened patent policy.

Lecture 3 on Global Efforts for Improving Quality Protein Maize (QPM)

The second Foundation Day Lecture was delivered by Dr. S.K. Vasal, Distinguished Scientist, Centre for Improvement of Maize & Wheat (CIMMYT), Mexico on 3 May, 2008 at NASC Complex, DPS Marg, New Delhi

Dr. Vasal mentioned that improving nutritional quality of crops was a noble goal. He emphasized that QPM was a great scientific breakthrough and a real success story for which maize scientists should feel proud of. Maize program in India had been involved in QPM research ever since the discovery of high lysine maize mutants. Initial emphasis was on soft opaques that led to the release of Shakti, Ratna and Protina in 1971. He further highlighted that marker assisted selection had also been deployed to convert some normal lines to QPM and a QPM version of Vivek 9 had also been developed.

Dr. S.K. Vasal delivering the 3rd Foundation Day Lecture

Dr. Vasal suggested following research areas for future consideration:

- There is need for more diverse QPM germplasm at inbred level.
- Specific QPM donors for various diseases and abiotic stresses are to be documented.
- Better understanding of modifying gene complex and regions where modifying alleles are present, need to be developed
- There is need to generate information to establish as to how the modification is affected at the biochemical and molecular level. There is already an indication that modified opaque-2 kernels contain increased amounts of gamma-zein protein.

- Research on genetic isolation mechanisms to prevent contamination of QPM by normal pollen should be pursued.
- A strong resource inbred base germplasm should be built by deploying more than one strategy, including inbreeding in basic QPM populations, F_2 pedigree populations and in some instances backcross populations and in limited cases converting normal to QPM.
- Well equipped biochemical laboratories should be established to provide rapid and reliable analyses.
- Practical strategies should be developed to speed up conversion process along with good recovery of kernel modification.
- Breeding procedures and strategies need to be deployed to form hybrid oriented populations for inbred extraction in homozygous genetic backgrounds.
- More research on storage grain pests is needed as it is related to kernel hardiness and ability to withstand insect pressure.
- Use of biotechnological tools to facilitate hybrid development should be taken up more aggressively.
- Conscious efforts are needed to identify more testers as part of on-going QPM research activities.
- More training programs are needed to attract talented researchers to carry out QPM research.
- Properly designed nutritional and feeding trials should be conducted for both human development and poultry production.
- Research on value addition in processed food and traditional preparations would help in achieving nutritional security.

Lecture 4 on Overcoming the World Food and Agriculture Crisis through Policy Change and Science

The fourth Foundation Day Lecture was delivered on March 6, 2009 by Joachim von Braun, Director General, International Food Policy Research Institute. He has been President of the International Association of Agricultural Economics.

The speaker discussed critically the importance of policy decisions and their impact with relevant examples.

Today's world food situation is shaped by volatility of food prices, low growth in agricultural productivity, and severe constraints to access of investment capital for agriculture in many countries. The sharp rise in global food prices in 2007-08 severely undermined the nutrition security of the poor, provoked social and political instability, and increased competition for limited natural resources. The crisis, however, also renewed the focus on food and agriculture on national and global agendas,

after decades of policy neglect and underinvestment in agricultural science, rural infrastructure, and institutions. India has responded strongly to the challenges in the world food system with policy actions.

Throughout the world, policymakers and the public long for simple solutions of these complex problems, but unfortunately, there are none. At the same time, some misguided policy actions have deepened the crises by threatening the open exchange of ideas, information, services, and goods.

Dr. Joachim Von Braun delivering the 4th Foundation Day Lecture

Policy proposals to overcome the world food and agricultural crisis are composed of three sets of needed complementary actions:

- Promotion of agricultural growth
- Reduction of market volatility, and
- Expansion of social protection and child nutrition action.

Lecture 5 on Climate Change and Food Security: From Science to Sustainable Agriculture

The fifth Foundation Day Lecture was delivered on May 7, 2010 by Dr. Mahendra M. Shah, Director, Qatar National Food Security Program. Dr. Shah has done excellent work towards sustainable agricultural development, food security, climate change, integrated agro ecological and socio-economic modeling, policy analysis, international agricultural investments and trade policy.

The speaker dealt with various national and international issues at length in his lecture.

Climate change results in irreparable damage to arable land, water and biodiversity resources, with serious consequences on food production and food security. The challenge in the 2050s will be doubling food production to meet the food needs of an additional 2.5 billion people, land expansion is not an option in all but a handful of countries. Over 75 per cent of additional food production will need to come from productivity increases.

Dr. Mahendra M. Shah delivering the 5th Foundation Day Lecture

In order to meet the challenges of climate changes, scientific and technological experiences of the last half century, including the remarkable progress in science based conventional breeding, will need to be combined with safe and ethical biological sciences-molecular genetics, informatics and genomic research and improved land, water and agrobiodiversity management systems, and environmentally sound livestock production and fish farming.

The scientific community, civil society, national governments, and the international development community bear the fundamental responsibility to achieve nutritionally healthy, productive and sustainable food systems.

Lecture 6 on Harnessing Research for Development: India's Agricultural Development

The sixth Foundation Day Lecture was delivered on August 12, 2011 by Dr. Uma Lele, Former Senior Advisor in the Operations Evaluation Department of the Food and Agriculture Organization. She has served on the High level Advisory Panels of the independent evaluations of the Global Environmental Facility in 2006, UNICEF in 2008, and was on the UNDP Panel in 2010-11.

Dr. Uma Lele delivering the 6th Foundation Day Lecture

The sharp rise in world food and fuel prices since 2007 has focused global attention on the role of agriculture in economic development. Following the Green

Revolution in the 1970s, a consistent decline in the real prices of food for nearly 30 years led to a global complacency regarding food supply. In exploring how to respond to the combined food and fuel crisis, the role of knowledge, both global and local, in modernizing agriculture seems to be particularly appropriate. India now is not only the country with the second highest rate of economic growth next to China, but it has also been a global leader in outsourcing, improving knowledge management systems of large private enterprises throughout the world. The lecture highlighted as to how India can bring its economic growth and information revolution to address the issues of modernizing its agriculture.

To achieve broad based agricultural development involving a large number of small dispersed farmers however requires not just technology capital but knowledge in a whole range of areas. This knowledge is embedded in the efficiency with which seed, fertilizer and pesticides are produced, delivered and applied by farmers.

Multiplicity of actors and a range of institutions supply information and knowledge in these various areas including agricultural research, extension and education systems, universities and think tanks, private sector traders and processors, non-governmental organizations, international development agencies and environmental organizations, the media and the formal and informal rule making system.

Whether the pace of growth or indeed even the process itself is sustained, or is prematurely aborted, is critically determined by the way information and knowledge are processed by key stakeholders in societies.

The way a country's institutions adjust to changing circumstances and challenges determines whether countries progress.

Seen from such a knowledge perspective how does India's performance look over time and space and relative to other countries?

India not only has the distinction of enjoying the second highest rate of economic growth next only to China's since the turn of the new millennium. There, nevertheless continue to be huge differences among states in per capita incomes.

Given that the poorest states depend the most on agriculture, Knowledge Management would seem to be a high priority for India's Agricultural Development.

India's agricultural growth has slowed with considerable differences in growth across crops and states. Growth of wheat has been the highest and close to 2%, rice is far behind and maize has been as low as 0.67%.

Indian experts are also calling for a total transformation of India's higher agricultural education to accelerate innovation.

Lecture 7 on Ensuring Food and Nutrition Security in Asia: The Role of Agricultural Innovation

Dr. Shenggen Fan delivering the 7th Foundation Day Lecture

The seventh TAAS Foundation Day Lecture was delivered on January 11, 2013 by Dr. Shenggen Fan, Director General of the International Food Policy Research Institute (IFPRI). Dr. Shenggen has conducted extensive research on pro-poor development strategies in developing countries in Africa, Asia, and the Middle East.

Dr. Fan highlighted that nearly 870 million people suffer from hunger today. Over 50 countries have levels of hunger that are "extremely alarming," many of which are in South Asia and Africa -South of the Sahara. According to the World Health Organization (WHO) of the United Nations, more than two billion suffer from micronutrient deficiencies with a significant share residing in Asia.

Asia's food and nutrition security is under stress due to many interconnected factors that include population growth, urbanization, demographic changes, increased labour cost, high and volatile food prices, natural resource constraints, and climate change. In order to achieve food and nutritional security in Asia an integrated and more innovative development agenda must be adopted in terms of strategies, investments, technologies, institutions, and partnerships.

In this lecture, Dr. Fan emphasized the important role that higher investments in agricultural research and development (R&D) and the resulting advances in agricultural science and technology play in reducing poverty and food insecurity in Asia.

Lecture 8 on Sustainable Agricultural Development – IFAD's Experiences

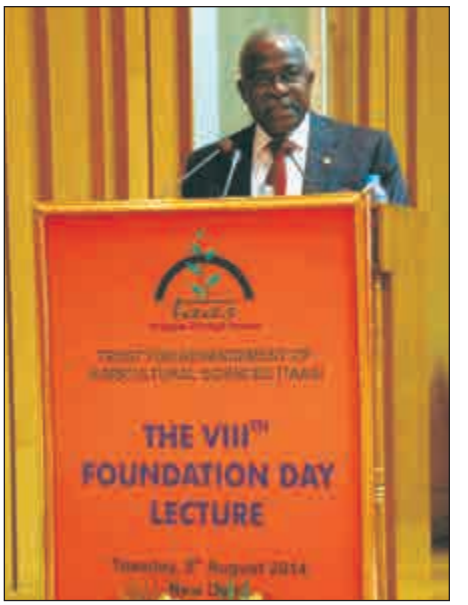
The eighth TAAS Foundation Day Lecture was delivered on August 5, 2014 by Dr. Kanayo F. Nwanze, President of IFAD. A Nigerian national, Nwanze has a strong record as an advocate and leader with a keen understanding of complex development related issues.

Dr. Nwanze started off by defining sustainable development and stressed that development is sustainable if it leads to inclusive economic growth so that changes take root and persist long after the aid workers and development agencies leave. He

described some of the experiences of IFAD and said that as a result of his interaction at ground level with people he had learnt 5 lessons, which are as follows:

- People must be at the center of all research and development
- There is no need to think small and be afraid of it
- The starting point for sustainable agriculture must be smallholder farmers
- Agricultural research is an essential element of sustainable development, and
- Poor rural people are not looking for charity

He concluded by asserting that only by following above tenets, efforts in agricultural development will be sustainable.



Dr. Kanayo F. Nwanze delivering the 8th Foundation Day Lecture

B. Special Lectures

Lecture 1 on Challenges in Developing Nutritionally Enhanced Stress Tolerant Germplasm

This special Lecture was delivered by Dr. S.K. Vasal, Distinguished Scientist, International Center for Improvement of Maize and Wheat and the recipient of World Food Prize on May 3, 2004. The highlights of the lecture are as follows:

Plant breeding research has resulted in a succession of landmark achievements during the twentieth century. We have witnessed a series of agricultural revolutions beginning with hybrid corn revolution in the US and later in Europe, China and now expanding into several developing countries of Latin America and Asia.

The list of crops deploying hybrid technology continues to expand covering even vegetables, horticultural and even self-pollinated crops like rice not amenable to hybrid research. Hybrid corn revolution was followed by green revolution in wheat and rice some thirty years ago. A demand driven livestock revolution is also underway in Asia contemplating demand for meat and animal products to double by 2020.

We are currently in the midst of an exciting and perhaps most dramatic revolution of our times. There have been considerable increase in the area planted to transgenic crops. The countries in the forefront are USA, Canada, Argentina, Brazil and China and the principal transgenic crops are soybean, cotton, maize and canola. The adoption

rates vary in different crops but are significantly higher in soybean compared to other crops. Two noteworthy traits in transgenic crops are herbicide tolerance and Bt insect resistance.

During the seven-year period (1996 – 2002), the global area of transgenic crops increased from 1.7 million hectares to 58.7 million hectares in 2002. Accompanying gene revolution is also scientifically revealing and informative. Human genome is already mapped and some crop species like rice, maize and others will also soon be mapped.

Hope with all this knowledge being generated at an accelerated pace, we may realize the dream of Dr. Norman Borlaug to be able to transfer useful genes from one crop species to another for genetic resistance to biotic and abiotic stresses and enhanced nutritional quality traits. Very often, he cited the examples of transferring rust resistance from rice to wheat and some specified proteins as gliadin and glutelin from wheat to other species as maize and others.

Recently, Egyptian scientists have successfully transferred drought tolerance from barley to wheat. Examples of this kind will certainly help plant scientists to tackle complex and difficult problems in an effective, efficient, and cost effective manner with a greatly reduced time span.

Lecture 2 on Global Perspective of Wheat Improvement

A special lecture was delivered on 18 December, 2010 at NASC Complex, DPS Marg, New Delhi by Dr. Sanjay Rajaram, former Director, Wheat Program, CIMMYT. He is one of the most distinguished wheat breeders known for his valuable contributions globally. His wheat varieties are grown on an estimated 58 million hectares worldwide. For his contributions, he has been honored with a World Food Prize and a number of national and international awards.

Dr. Sanjay Rajaram, former Director, Wheat Program at CIMMYT, Mexico and the recipient of 5th Dr. M.S. Swaminathan Award for the year 2010 gave a global perspective of wheat program. He spoke about meeting the increasing demand of wheat due to increase in population and indicated that there will not be easy solutions as this demand has to be met from the available area and lower genetic gains due to technological fatigue. Though solutions are not easy but he firmly believed that the target of 100 million tons can be achieved. Speaking on the global scenario, he highlighted the fact that worldwide the area under wheat is 217 million ha producing 621 million tons with productivity of 2.9 t/ha, which is very low. The developing countries have a little more than half of the acreage with a little less productivity and production of 308 million tons.

Wheat is very important is the daily consumption for countries like India and China as it provides 500 calories per capita per day which is nearly a quarter of the daily requirement. This component alone will have large implication in wheat market

chain at global level where, on an average, 100 million tons is traded annually in the international market. Fast adoption of improved varieties has occurred in India as compared to Latin America and China, while substantially lower in Middle East and Africa. He mentioned that during the first three decades starting from 1965, wheat production in India increased by 3 per cent per year while from 1995 to 2005, the productivity growth remained sluggish at 1 per cent per year.

Hence, to meet the target, a substantial rise in the productivity growth rate in the range of 1.6 - 1.8 per cent per year is required. Declining international price of wheat will also have an implication on how the targets will be met. It is expected that by 2020, the requirement for wheat will be somewhere between 750 - 800 million tons against the current production of 620 million tons. This will be mainly due to the additional demand of wheat for animal consumption and biofuel. It is expected that nearly 50 per cent of this requirement will be met from Asia alone.

He summarized that change in wheat area, adoption of modern varieties having high yield potential, pricing, government policies and international collaboration with CIMMYT facilitated the green revolution. He also outlined the drivers of future revolution Such as molecular marker assisted development of transgenics, development of climate resilient varieties, selection of varieties resistant to Fusarium, yellow rust, Hessian Fly and abiotic stress. He concluded by stating that both crop improvement and efficient natural resource management strategies have to be integrated.

Lecture 3 on Challenges and Opportunities for Food Legume Research and Development

A special lecture was delivered on 25 January, 2012 at BP Pal Auditorium, IARI, Pusa Campus, New Delhi by Dr. M.C. Saxena, former Assistant Director General (ADG), ICARDA, Syria. He is an eminent agronomist and crop physiologist, whose work at the International Center for Agricultural Research in the Dry Areas (ICARDA) on food legumes has enormously benefitted the resource poor farmers in West Asia, North Africa, Central Asia.

Food legumes, such as chickpea, cowpea, dry beans, dry peas, faba bean, lentil, mungbean, pigeonpea, urdbean and other pulse crops are a good source of dietary protein, to complement the cereal-based diet, particularly for vegetarians, in the developing world.

However, the global production of food legumes has not kept pace with increase in the global population. Therefore, there is general trend of decline in global per capita availability and consumption of pulses. This should obviously have nutritional consequences for the societies that primarily depend on pulses for enriching their daily food. In India, the production declined from 13.77 kg/yr in 1990 to 11.40 kg/yr in 2006; Fortunately, there is some resurgence in the last five years and the

availability has improved to 12.44 kg in India and 9.1 kg/ha in the world as a whole. The major factor responsible for poor growth in production of the food legumes is their low productivity.

Recent developments offer unprecedented opportunities to legume researchers for meeting the challenge of enhancing the economic competitiveness of the pulse crops through genetic improvement, and development of appropriate management practices that reduce their cost of production and permit full realization of their genetic yield potential.

A recent study indicated that the overall consumption of pulses would increase by 10 per cent by 2020 and 23 per cent by 2030. The increased demand for consumption would necessitate an yield increase of 70 kg/ha by 2020 and by 120 kg/ha by 2030. Application of science and technology, along with effective technology transfer and policy and institutional support to farmers, should make this target reachable.

Lecture 4 on Enhancing Smallholder Farmer Participation in Markets: The IMOD Way

A special lecture was delivered on 24 June, 2013 at IARI, Pusa Campus, New Delhi by Dr. William D Dar, Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Dr. Dar has made outstanding contributions towards food security and agricultural sustainability in Asia and Sub-Saharan Africa. His work has created great impact on the lives of resource poor farmers.

Dr. William D Dar, DG, ICRISAT delivering the Special Lecture

Dr. Dar mentioned that in the early 1970s mass famines were considered to be inevitable in the developing world. Food production was falling well below the needs of the ever increasing populations. Therefore, increasing food production was CGIAR's top priority. With the Green Revolution in rice and wheat, production of food was so rapid that the conditions of famine were averted. But, the Green Revolution varieties were not suited for cultivation in dry areas as they were irrigation and fertilizer intensive. Therefore, the condition of farmers in these areas remained bad. To add to the woes further, in 1990s the policies of economic liberalization brought major economic upheaval to the

developing world. Agriculture slipped to lower priority as marketing was deregulated. Poor farmers were left on their own. They suffered from hunger not only because they were not growing enough food but because they were unable to buy the food. In order to become food secure, they needed both increased food production and increased incomes.

In 2008, the World Bank produced a comprehensive report based on analysis of new trends in agriculture "Agriculture for Development" which stressed that production is mainly by small farmers.

The state regulates the competition and supports greater inclusion of smallholder farmers. In this vision, agriculture assumes a prominent role in the development agenda. Implementing this vision, objective number one became "Improve access to markets and establish efficient value chains". In order to escape hunger and poverty in dryland area small holders needed to have better access to markets. ICRISAT decided to make it the centre piece of their strategy i.e. the Inclusive Market Oriented Development (IMOD) Way.

Dr. Dar further elaborated how incomes of these poor farmers increased by adopting innovative farm practices, developed by ICRISAT like, micro-fertilization, crop diversification and watershed management, etc. combined with risk management by government and non-govt. organizations and easy market accessibility.

6 Strategy Papers

The Trust for Advancement of Agricultural Sciences (TAAS) has brought out eight strategy papers on topics of considerable importance. These papers do provide crucial information on each subject and have been authored by Dr. R.S. Paroda, Chairman, TAAS, Former Director General, ICAR and Secretary, DARE, Government of India. He is an accomplished plant breeder and geneticist and is known for his analytical thinking as well as vision on agriculture related matters. His vast experience at national, regional and global level is reflected in these strategy papers which TAAS has published and disseminated widely. A list of strategy papers published and gist of these papers are provided below. The detailed strategy papers are also available on the TAAS website<www.taas.in>.

1. Strategy for Increasing Productivity Growth Rate in Agriculture" - Strategy Paper by Dr. R.S. Paroda. August, 2006.
2. Imperatives of Global Climate Change for Agricultural Research in Asia-Pacific - Strategy Paper by Dr. R.S. Paroda. November, 2009.
3. Intensive Efforts Needed for Food and Nutrition Security - Strategy Paper by Dr. R.S. Paroda. November, 2009.
4. NSAI Foundation Day Lecture on "Revitalizing Indian Seed Sector for Accelerated Agricultural Growth", by Dr. R.S. Paroda. October, 2010.
5. Strategy Paper on "Implementing the International Treaty to Address Current Concerns about Managing our Plant Genetic Resources" by Dr. R.S. Paroda. January, 2012.
6. Special lecture delivered at Indian Seed Congress 2013 on "Indian Seed Sector: The Way Forward" by Dr. R.S. Paroda. February, 2013.
7. Strategy Paper on "Managing our Water Resource for Increased Efficiency" by Dr. R.S. Paroda. May, 2013.
8. Strategy Paper on "The Indian Oilseed Scenario: Challenges and Opportunities" by Dr. R.S. Paroda. August, 2013.
9. Strategy Paper on "Need for Linking Research with Extension for Accelerated Agricultural Growth in Asia" by Dr. R.S. Paroda. September, 2014.

1. Strategy for Increasing Productivity Growth Rate in Agriculture

To attain a sustained growth rate of 8 per cent during XI Five Year Plan, India must accelerate the pace of agricultural growth from the current around 1 per cent to at least 4 per cent. Hence, a Mission Program for Accelerating Productivity Growth Rate in Agriculture is called for as a matter of priority. It would need a dynamic approach oriented towards focused strategy which is well planned, coordinated and monitored. Business as usual will not work. Concerted efforts would be required for meeting the targets that are achievable but were not so well addressed in the past in a holistic manner.

Following are the ten strategic areas along with proposed action plan that need to be pursued rigorously on agricultural front:

i. Increased Capital Investment in Agriculture: Capital Investment in Agriculture needs to be enhanced from present less than 10 per cent to at least 15 per cent. Investment on infrastructure in rural areas such as roads, markets would accelerate faster growth in agriculture sector.

ii. Supply of Growth Oriented Inputs at Farmers' Doorsteps: Growth oriented agriculture would demand following inputs:

- Supply of quality seeds: It is extremely important to provide better quality seeds to the farmers
- Supply of fertilizer: It is necessary to accelerate the annual mineral fertilizer consumption rate to at least 5 per cent. Also, target of at least 5per cent for biofertilizer use has to be achieved in the XI plan.
- Supply of biocontrol agents and biopesticides: Supply of biocontrol agents and biopesticides for enhanced use in crops such as vegetables, pulses, rice, maize, sorghum, sugarcane, cotton etc. will need special emphasis.
- Use of farm machinery: Increased use of efficient and cost-effective farm machinery and equipment has to be promoted through large scale fabrication.

iii. Improving Productivity: India is much behind China and Brazil in productivity, which has to be increased through efficient management of natural resources. Some concrete action would be needed in the following areas:

- Adoption of well planned strategy for increasing production: India can become No. 1 (surpassing China) in near future if an aggressive and well planned strategy is adopted for increasing wheat production – using both area expansion and enhanced productivity approach
- Stabilizing area and production of rice: A new strategy needs to be evolved by which area, especially under rainfed rice (having low productivity), could be reduced with simultaneous increase in yield using hybrid rice, integrated pest management (IPM) and conservation agriculture technologies.
- Enhancing maize production: Yield potential of maize can be enhanced significantly by promoting single cross hybrids.

- Sugarcane for biofuel: In view of spiraling prices of petrol, it is high time to have a policy reorientation towards use of sugarcane for biofuel production by increasing sugarcane productivity in the northern states of India, which is quite low at present despite large acreage.
- Increased productivity of pulses: Improved short duration, disease resistant varieties are to be popularized. Short duration varieties need to be promoted in new areas such as chickpea in south, urdbean in rice fallows, in coastal region of Andhra Pradesh, Orissa and West Bengal, pigeonpea in the north-west (Haryana, Gujarat and Rajasthan).
- Increasing oilseed production:
  - Soybean- Soybean could become No. 1 oilseed in India provided a major effort is mounted in this direction. Another important policy related issue is regarding use of GM soybean
  - Groundnut-- Use of improved varieties, higher rate of seed replacement, use of sulphur and plastic mulching, besides IPM, can result in significant improvements in states of Andhra Pradesh, Karnataka, Maharashtra and Madhya Pradesh.
  - Rapeseed and Mustard- Expansion of area in eastern States (West Bengal, Assam, Bihar) and north eastern states would help in higher production. Hybrid technology could be exploited in the northern and western states.
  - Hybrid Castor and Safflower- Promoting use of improved hybrids and, wherever possible, use of one irrigation would make all the difference. Good hybrids are now available for large area coverage.

iv. Making Gray Areas Green: In order to achieve Evergreen Revolution, there is a strong need to lay special emphasis on rainfed agriculture

v. Emphasis on New Area Approach: New area approach can lead to faster progress on account of quick adoption of technological package. Examples are: hybrid rice in eastern India, soybean in eastern and NE region, sunflower in the north etc,

vi. Major Thrust on Horticulture: Right policy decision, technical guidance and funding support for initial establishment can make all the difference. Opportunities for linking farmers to markets, processing and value addition are all critical for the growth of horticulture sector.

vii. Promoting Inland Aquaculture: This would require special thrust, both, on research and development side – including support for the production and supply of quality seed, rural based fish processing, packing, and cold storage facilities and transportation as well as export promotion.

viii. Capitalizing on Livestock Sector: India has the largest cattle and buffalo population, second largest population of goats and the third largest of sheep in the world. India is also the largest milk producer (91 mt) in the world today. Yet, it has not been possible to compete globally in the export of milk products. There is need

to link farmers to market. In some areas, such as Rajasthan and Maharashtra, major thrust should be on silvi-pastoral practices using agro-forestry and use of rangeland pastures and legumes. Also, there is need to protect and improve the local breeds

ix. Improved On-farm Efficiency and Precision Farming: Most critical factor for faster growth in future will be the input use efficiency. It would demand integrated natural resource management and precision farming through adoption of small scale farm machinery/tools (such as zero till drill, planters, seed and fertilizer drills, sprinklers etc.)

x. Critical Policy Interventions Needed: Enabling policy environment is critical for future growth and development. It is, therefore, necessary to continue having appropriate policy interventions in future as well.

2. Imperatives of Global Climate Change for Agricultural Research in Asia-Pacific

Major challenges in the twenty-first century are the rapid increase in the world population, degradation of agricultural land and other natural resources and emission of greenhouse gases that contribute to climate change. Hence, there is growing threat of food insecurity. Emissions of greenhouse gases, like carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), resulting from human activities, are substantially increasing the average temperature of the earth's surface.

Rapid increase in population implies increased demand for food in the region. It is estimated that by 2020, food grain requirement in Asia would be 30-50% more than the current demand which will have to be produced from same or even less land that too with inferior quality of other natural resources. Alleviating poverty and attaining food security under adverse environmental scenario due to global climate change would be a major challenge in the 21st century.

These facts draw attention for global concerns and urgency to address the options by which threats to Asian agriculture, due to climate change, can be addressed successfully in the near future. On positive side, the agriculture sector also provides significant potential for the greenhouse gas mitigation and adaptation to climate change effects. This would demand reorientation of agricultural research.

Drastic changes in climate are affecting agriculture considerably through their direct and indirect effects on crops, soils, livestock and pests, and ultimately the global food security.

Extreme events including floods, droughts, forest fires, and tropical cyclones have already increased in temperate and tropical Asia in the last few decades. Runoff and water availability are projected to decrease in the arid and semi-arid regions of Asia. The issue of climate change and its imperatives for agricultural research was deliberated in an International Symposium organized jointly by APAARI and JIRCAS.

Thirty countries came out with agricultural research priorities for adapting agriculture to climate change in the form of "Tsukuba Declaration"

The salient features of "Tsukuba Declaration on Adapting Agriculture to Climate Change" are given below:

- Water is a key constraint in the region for attaining food production targets and will remain so in future as well. Steps are, therefore, needed by all the stakeholders to prioritize enhanced water- use efficiency.
- It was fully recognized that increasing food production locally will be the best option.
- New genotypes tolerant to multiple stresses, viz., drought, floods, heat, salinity, pests and diseases, will help further increase food production.
- A reliable and timely early warning system of impending climatic risks could help determination of the potential food insecure areas and communities.
- Appropriate policies and institutions are needed that assist in containing the risk and to provide protection against natural calamities.
- Governments of the countries in the region should collaborate on priorities to secure effective adaptation and mitigation strategies.
- It was recognized that adoption of scientific soil and crop management practices, improving degraded lands, enhanced fertilizer- use efficiency, and large scale adoption of conservation agriculture will be necessary.
- Coping with global climate change is a must and for that there are two strategies
    i. adaptation through learning to live with the new environment (e.g., time of planting, changing varieties, new cropping systems, etc.), and
    ii. mitigation through offsetting the causative factors such as reducing the net emission of greenhouse gases.

Epilogue: Impact of climate change on agricultural production in the Asia- Pacific is real. Hence, immediate action at national level to understand and address the issues of climate change becomes a priority. Strategy around both adaptation and mitigation is called for, which would require research reorientation and major policy interventions. Regional and global collaboration would help in addressing these concerns and for building both institutional and human resource capabilities being the two cradles for sustainable agriculture.

3. Intensive Efforts Needed for Food and Nutrition Security

There are many issues and concerns that require our immediate and continuous attention on the issues of 'food, nutrition and environmental security' in the ever-changing contexts of new challenges, technology advancements, and policy developments. This millennium theme, jointly envisioned by all the science academies

in India, was released by the then Hon'ble Prime Minister Shri Atal Bihari Vajpayee during the 88th Indian Science Congress held in New Delhi in January, 2001. In India, the ever-increasing population in fact nullifies all our efforts. Every year we add one Australia to our population needing additionally 4 to 5 million tons of food grains. Over the years per cent GDP from agriculture sector is declining but it is well established that unless we have 4 per cent growth rate from agriculture, expected 8 per cent industrial growth would not be possible. So, agriculture continues to be the backbone for India's overall development.

The science based progress was made possible mainly due to change in the plant type, by making the crop respond better to higher inputs and giving higher productivity. Also, successes in developing varieties resistant to various pests and diseases, support by policy makers, and the effective alliance of the NARS (National Agricultural Research System) with International Agricultural Research Centers (CIMMYT and IRRI) and farmers contributed to such progress. Yet the concerns of economic and ecological access to food, and the poverty issue continue to prevail (although we have been able to reduce poverty by about 40%). The MDGs (Millennium Development Goals) have drawn our attention towards eradication of poverty and environmental sustainability. We need to ensure better income for our people and see that they are above poverty line and have easy access to food. Furthermore, nutrition security has become a major concern which needs to be simultaneously addressed. We have also been experiencing factor productivity decline on account of second generation problems of Green Revolution such as: salinity, lowering of water table and increased incidence of pests and diseases. A global decline in production of foodgrains has also resulted in price rise per ton of wheat and rice thereby obviously affecting the consumers badly. The foodgrains are also being diverted as feed; thus making their availability even more difficult. Lately, countries like USA are diverting their one-third maize production towards bio-fuel production, which appears to be ethically wrong. Climate Change concerns are also serious.

We must, therefore, think seriously to remain self sufficient. In particular, we need to reorient our research for development strategy:

- A twin pillar approach for a paradigm shift; germplasm improvement (good varieties and hybrids) together with improved natural resource management.
- Consideration of socio-economic aspects and policies around diversification of agriculture.
- Biotechnology should supplement (but not replace) plant breeding efforts. Recently, in India, both Bt brinjal and Bt corn have been permitted for field tests. In future, I do not know whether there will again be a resistance for acceptance of transgenic technologies. In any case, these technologies are required in country's long term interest.

- Advances should be made in harnessing the hybrid technology in crops like wheat and rice. Similarly, single cross hybrid maize technology should be promoted in India. Both public and private sector can contribute very well.
- New area - new crop approach has a high potential in the country (based on several success stories of the past) for enhancing the food and nutrition security by increasing the overall productivity and production.
- PPP is essential to provide enabling environment for future growth in agriculture. There is an obvious need for building mutual trust. Government should come out with proper policies, and put in place incentives for those who perform.
- We should move forward and undertake research in up-stream areas of strategic importance, and to make sure that our knowledge gets translated into products that can benefit the end users. For implementing the translational research projects scientists/technicians should work with the farmers in a participatory mode.
- Agri-clinics should be established through creation of technology agents who can provide much needed vocational training for much needed custom-hire services to the farmers needs. This requires a well-considered policy support and awareness creation. Private sector and NGOs should be encouraged to play their roles in this regard.
- More capital investment in agriculture from all sources should be attracted.

4. Revitalizing Indian Seed Sector for Accelerated Agricultural Growth

India recorded an unprecedented growth in agricultural production during the last 50 years. The first phase of agricultural growth was on account of 'Green Revolution' during the late sixties and seventies, with the introduction of semi-dwarf high yielding varieties (HYVs) of wheat and rice. As a result, substantial increase in food grain production from 50.3 mt in 1952 to 88.1 mt in 1971 was realized. During this period, significant role towards quality seed production of HYVs was played mainly by the public sector seed organizations viz., NSC, SFCI, State Farm Corporations, Indian Council of Agricultural Research (ICAR) Institutes, State Agricultural Universities, etc.

A significant policy decision of the ICAR to share freely the parental seeds of hybrids with the Private Sector catalysed the process of increased productivity as well as cropping intensity (from 118.6% in the early seventies to 133.8% in nineties). Subsequently, Government enacted the Protection of Plant Varieties and Farmers' Rights Act, 2001 to ensure faster growth of our seed sector. All these initiatives helped Private Seed Sector in India to play much bigger role.

Vegetables are the fastest growing sector. The hybrid vegetable seed market in India is of about Rs 1500 crore. There was an increase of 194 per cent in vegetable hybrid seed market during 1998 to 2008, and it is expected to grow further. Public research institutes played a key role in establishing the vegetable variety

improvement and seed production. However, the R&D in vegetables is also very active in the private sector. Out of about 110 vegetable hybrids released 60 per cent have been developed by the private sector. With the rapid pace with which biotech innovations are being tested, the market share of vegetable hybrids is expected to rise. However, as stated earlier, a decelerating productivity growth rate, increasing prices and demand of food grains, shrinking natural resources and the emerging challenge of climate change have emerged lately as major concerns for the policy makers and the scientists. To attain a national GDP growth rate of 8 percent, it is necessary that agricultural growth rate is raised from 2 to 4 per cent. Best way to achieve this is through greater coverage under HYVs and hybrids.

This paper highlights the key role of seed industry in accelerating agriculture growth. A process of revitalization is needed urgently to accelerate the pace of seed production. It is with this objective in mind, the following suggestions were made:

- Seed replacement has to be linked with new variety replacement too.
- For achieving desirable levels of seed replacement rate, adequate seed needs to be produced first.
- Production of hybrid seed needs to be promoted aggressively to improve crop productivity.
- Complementarity of the public sector policy and infrastructure and the private sector dynamism can be maximized through appropriate Public- Private Partnerships (PPP).
- The success of partnership lies in trust, openness, and transparency. This can be built by regular interactions and dialogues, and appropriate policy framework.
- Good models and success stories on PPP existing in the NARS and the CGIAR system, such as that of IARI, NRCPB, IIHR, ICRISAT, IRRI, etc., can be replicated or further refined, as needed, by other institutions/universities.
- There is an urgent need to build crop-based/ institution-based Technology Parks/ Incubators.
- Seed quality assurance requires considerable investment in terms of proper infrastructure, equipment and competent human resource.
- There is an urgency to have the Seed Bill enacted soon.
- Re-structuring and revamping the public sector seed producing undertakings is also required for product diversification/ upgradation and for improving their governance, core competence and competitiveness.
- Specific interventions through active involvement of National Seed Association of India (NSAI), to boost our seed exports, need urgent consideration.
- A National Mission on Seed needs to be launched by the Central Government so as to provide an enabling environment for faster and an efficient quality seed production program.

- The national germplasm collection available at the NBPGR, needs to be made available more freely on request,
- The share of Private Sector investment in plant breeding and seed development area has increased in recent years and needs to be further enhanced.
- For crisis management, there is a strong need to establish Regional Seed Banks as a contingency measure.

Also a serious effort is needed to revitalize our national seed sector, for which a missionary zeal is warranted to accelerate the pace of Indian agriculture.

5. Implementing the International Treaty to Address Current Concerns about Managing our Plant Genetic Resources

For strengthening national capacities to implement the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) it is essential to promote the active participation of countries in the multilateral system. For the effective implementation of the multilateral system of access and benefit-sharing at country level, there are a number of core requirements to be fulfilled, according to the needs of each country.

Three important things about genetic resources are to be kept in mind. First, that genetic resources are the building blocks for improving productivity; Second, that genetic resources are the common heritage of humankind; and Third, that genetic resources are to be freely exchanged for human welfare.

The Convention on Biological Diversity envisioned that genetic resources were to be conserved for posterity. It was realized that conservation is not only required for 'posterity' but also for 'use'. The Food and Agriculture Organization of the United Nations (FAO) has begun a Global Initiative to build required capacity for enhanced use of genetic resources.

We are greatly concerned with agricultural crops, which are immediately necessary for the food and nutritional security of humankind. Thus, a dialogue was initiated under the auspices of FAO to revise the International Undertaking on Plant Genetic Resources. The deliberations culminated in the development of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). At that time, there was a general consensus that only plant breeders should have rights, the definition of farmers' rights was not known. While chairing the FAO Working Group on Farmers' Rights, it was realized that not only plant breeders but also the farmers should have rights over their landraces and varieties.

The ITPGRFA came into force in 2004, and in 2006 its governing body adopted the standard material transfer agreement (SMTA) under the treaty. In India, it was envisioned that there would be a bilateral system of germplasm exchange under the CBD, and multilateral exchange under the umbrella of the ITPGRFA. The Government

of India enacted the Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act in 2001, to provide for the protection of plant varieties, the rights of farmers, plant breeders and researchers.

The food basket in India today would have been entirely different had there not been free exchange of genetic resources.

A large amount of germplasm of Indian origin was acquired by international genebanks. This germplasm is being globally exchanged continuously through the ITPGRFA. It is paradoxical that India has yet to agree upon a mechanism under the ITPGRFA to implement the multilateral exchange of crops, while most of our germplasm is already held in the global multilateral domain. Asia-Pacific Association of Agricultural Research Institutions (APAARI) has played a significant role in creating awareness about the enhanced use of genetic resources through multilateral exchange using the SMTA.

The farmers are the custodians of many traditional varieties and landraces. Currently, their rights are being protected through the PPV&FR Act.

In order to harness the benefits of these protocols and treaties, a national strategy is urgently needed for the convergence and coordination of all relevant issues/legal requirements to make a step forward so that a targeted section of our society is benefitted.

There is an urgent need for a coordinated effort at the national level, to put in place decisions through regular consultations involving all relevant organizations. It was decided that the Department of Agricultural Research and Education in coordination with the National Biodiversity Authority, must take immediate steps towards providing access to the germplasm of crops under the multilateral system as per the provisions of the ITPGRFA.

Furthermore, there is also a need for the harmonization of different protocols/ treaties. I am a strong advocate of the concept of benefit-sharing, and in view of this, I have been urging the Chairman, PPV&FR Authority to garner government support for the creation of an Indian Gene Fund of around Rs. 50 crore (US$ 10 million), which seems to have been included in the 12th Five Year Plan.

There is an urgent need for partnerships amongst all stakeholders, including public and private sector, NGOs and farmers.

India is richly endowed with a wealth of genetic resources, which it used to nurture. We have been debating and making a good case for effective and rather urgent implementation of farmers' rights and benefit-sharing with local communities. This process has to be initiated without further delay. Today, there are over 400,000 accessions, of which 200,000 were collected in just five years. This was achieved through a participatory approach. However, this enormous wealth of germplasm must now be systematically characterized, evaluated and shared for effective use.

Germplasm must be shared more freely in India through the multilateral system, under the ITPGRFA, using the SMTA. There are serious challenges before us. Hence, we need to put all our energy and actions together and have a clear road map before us so as to address both the national as well as international concerns more effectively for the benefit of humankind.

6. Indian Seed Sector: The Way Forward

In order to bring about the 'Change' that our agriculture needs today horizontal expansion is no more a choice. Vertical expansion is the only option to move forward. For this, improving productivity through good quality seeds of improved varieties/ hybrids is the best possible alternative.

In order to meet the demand of our increasing population, likely to be 1.7 billion by 2050, we shall need to double our food production. This can only be possible by bridging the existing yield gaps through enhanced productivity and integrated natural resource management. Hence, the second Green Revolution would need much faster growth of seed sector. For this, a Mission on Seed Production is urgently needed. The seed sector grew steadily with the establishment of several private seed companies. Growth of private sector began in early nineties when ICAR took a bold decision of providing breeder seed of parental lines of public bred hybrids, and varieties freely to the private sector. This enabled private seed companies to grow much faster. Liberal policy of importing seed and planting materials of best varieties resulted in substantial private investments in the seed sector.

Technology Led Growth **:** The enactment of the PPV&FR Act and rapid expansion of Bt cotton production area has enhanced the demand for Bt cotton hybrid seed by 220 per cent. India could turn into a net exporter of cotton from being an importer. In this case, the private sector took the lead in accessing the technology. This led to higher growth of Indian seed industry around US$ 2,000 million. For raising the agricultural productivity, seed is recognized to be the most critical single input. Use of good quality seeds can result in as much as 15-20 per cent yield increase. The availability of quality seed is sufficient to meet the current requirement. However, many a times the seeds of new improved varieties are not available to the farmers. The subsidy linked to certified seed of field crops of large volume and low value has proved counter-productive to the variety replacement rate. Extending the scope of government subsidy to truthfully labeled seed of promising hybrids, produced by private companies, would be yet another bold policy decision.

Varietal Denotification **:** It is high time that we denotify on priority such old varieties that have no demand or relevance in the present context. Continued production of seed of old varieties by many State Corporations is rather counterproductive.

Need for Enhance Replacement Rate **:** For achieving the desired levels of seed replacement rates, adequate seed of good varieties need to be produced first. In the last two decades, the ICAR institutes and SAUs have made significant progress in meeting

fully the breeder seed requirement. States must ensure production, multiplication and replacement of seed progressively, especially in respect of regionally important varieties. The state departments may consider procuring quality seeds of improved crops varieties through a Contract Seed Production system. This will ensure timely availability of sufficient quantities of seed of the desired (new improved) varieties.

Good Future Prospects **:** Advantage of diverse agro-climatic conditions, developed institutional infrastructure and availability of skilled human resource can certainly make Indian seed business globally competitive. India's seed export can be increased many fold from current US $ 400 million There is need to have an aggressive approach and develop strategy to capture seed markets abroad in a well planned manner.

Investment Towards Innovation **:** The seed sector had been quite active to outscale new innovations in agriculture. Such innovation encompasses development of superior hybrids, transgenics and advanced seed treatments. Acceleration of hybrid seed production in these crops both by the Public and Private Seed Companies is the need of the hour. Better climate resilient hybrids and varieties in all major crops need to be developed both by the public and private research institutes.

Role of Biotechnology **:** There is need for greater focus on the application of biotechnology to develop new improved varieties with special traits, particularly to provide effective and durable solutions against abiotic and biotic stresses. It will be appropriate to generate much needed awareness among farmers, civil society organization and the policy makers about the potential of plant biotechnology as well as its safe application. Research is needed to meet the growing demand for high quality seeds of improved varieties/hybrids with high productivity higher proteins, minerals and vitamin contents. The Golden rice, QPM and Fe and Zn enriched millets are some such examples.

Investments in AR4D **:** It is encouraging that for advancement in research and technology development in agriculture, the ICAR got enhanced plan allocation almost 2.5 times in the XII Plan period. The private seed sector is also expected to make significant investments in the AR4D. it is presumed that private sector is currently spending on R&D about 10-15% of the total turnover.

Promoting Hybrid Technology **:** More public-private funding is needed to develop HYVs/ hybrids for varying agro-climatic regions. The increased investments made by the private sector have resulted in better innovations and technology development over the years. It is encouraging to note that the contribution of the private sector has been quite remarkable in the expansion of the vegetable basket.

Building Public Confidence **:** The private sector has shown its confidence and interest in the national system by applying for the protection of their plant varieties with the PPV&FR Authority. Out of 4267 applications received by the PPV&FR Authority, 1796 were from the private sector. To fulfill the social commitment, the private sector also needs to release and promote high yielding OP varieties of crops where hybrid technology is yet not feasible.

Partnership for Prosperity **:** India is a country of diverse agro-ecosystems and cropping preferences. It is predominantly rainfed (~60%) and size of the farm holdings are rather small (~67%). The wide gaps reported between the potential and realized productivity in most of the crops can be bridged to a large extent by using the seeds of improved varieties. A recent study has shown that the use of HYV seeds was one of the key factors for an impressive increase in production. The fact that even today nearly 70-75 per cent of the total seed requirements is met by the farm-saved seed, should also be seen new opportunity to expand and meet the diverse needs of our smallholder farmers. It is beyond doubt that public-private-partnership in seed sector is critical for future growth of Indian agriculture.

Germplasm Exchange **:** The National Bureau of Plant Genetic Resources (NBPGR) acts as a national repository of plant genetic resources, but also acts as an apex organization facilitating germplasm conservation, access and exchange for research purposes, which can be of great significance in plant breeding programs. However, as these resources represent our invaluable national asset, utmost care is needed to develop guidelines on access and benefit sharing (ABS), on lines of standard MTA of the ITGRFA, with necessary safeguards.

The Way Forward **:** We must accelerate pace for seed development by defining a clear "Road Map" for future.

7. Managing our Water Resource for Increased Efficiency

India with 2.4 per cent of the global geographical area and only 4.5 per cent of water resource supports about 17 per cent of the human and 11 per cent livestock population of the world.

Per-capita availability of land for producing agricultural commodities has declined from 0.48 ha in 1951 to 0.15 ha in 2,000 AD and it is expected to decline further. Availability of fresh water for agriculture is expected to decline with global-warming. Population growth, declining land and water quality, coupled with challenge of climate change, have created much greater concern to feed our ever growing population. Thus, the challenge has to be addressed with strategic approach utilizing innovations in science and technology.

Emerging Challenges

i. ***Declining Water Resource:*** In India, currently about 80 per cent of available water is consumed for agricultural production, whereas, this share will be reduced to about 70 per cent by 2025 due to increasing demand of water for industry and drinking purposes. Although, India has the largest irrigation system in the world, its water-use efficiency has not been more than 40 per cent. If it continues like this, the water crisis would result in reduced production and productivity, which would affect our food and nutritional security. Currently, only 38 per cent of cultivated area is irrigated. More efforts are needed to cover

additional area to enhance productivity. Studies have shown that improving water productivity by 40 per cent on rainfed and irrigated land could reduce the need for additional withdrawals over the next 25 years to zero.

ii. ***Challenge of Climate Change:*** Enhanced CO_2 concentration may enhance photosynthesis in C_3 crop species but increased temperature may increase water use and hasten the process of maturity. Innovations and strategic approaches may convert weaknesses into the opportunities. Adaptive mechanisms like time adjustment and productive use of water shall reduce the negative impact. These challenges could be addressed through identification of genes tolerant to high temperature, flooding and drought. Adoption of conservation agricultural technologies could be important. This would need reorientation of research agenda to address emerging challenges.

Crop Management Options

i. ***Water Productivity and Water Use Efficiency:*** Water productivity denotes the output of goods per unit volume of water. However, productivity of water could be enhanced either by saving water use or by increasing the productivity. Relocation of water from low value to higher value uses would generally not result in any direct water savings but can directly increase the economic productivity of water. Suitable water application methods, varieties and management practices will have to be evolved. In agriculture, water use efficiency at the field level will amount to crop output in physical terms i.e. crop yield per drop.

ii. ***Water Productivity through Crop Improvement:*** The productivity of water irrespective of environment will be governed by those factors which minimize water losses from the soil system and improve the transpirational water use by the crops. Water productivity with respect to evapo-transpiration varies considerably for different crops. Modern rice varieties have about a three-fold increase in water productivity. Similar is the case with modern dwarf wheat. Potential production rates of C_3 plants is around 200 kg dry matter/ha/day and those of C_4 plants between 200-400 kg dry matter/ha/day. In some succulents, when stomata remain open during the night and close during the day, such adaptations are important from carbon and water economy point of view. To mitigate the impact of drought and heat tolerance in climate change scenario, putative traits which could be beneficial over long time scale should include phenology, like osmotic adjustment, rooting characteristics. Molecular markers and Quantitative traits loci for osmotic adjustment and rooting characteristics could open the way for easy screening of genotypes for these traits. In India, out of water diverted to agriculture only about 10 per cent of water is used for horticultural crops. However, majority of the horticultural crops are perennial they invariably have deep and extensive root system, capable of extracting water from deeper layers. Hence, they have better productivity than field crops.

Farm Management Options

Higher water productivity requires selection of appropriate crops and cultivars and proper soil and water management technology. Cultural and agronomic practices that reduce the soil evaporation, run off, deep percolation, transpiration by weeds, application of mulches, micro-irrigation could improve water productivity. Pressure irrigation system along with fertilizer application (fertigation) resulted in remarkably high water use efficiency. Drip system of irrigation has helped in increasing yield and saving of water especially in high value horticultural crops like grapes, banana, strawberry, citrus, mango, cashew-nut and coconut.

i. ***Augmenting Poor Quality Waters:*** In future, reclamation and proper use of brackish and sewage water could be an additional option for increasing water productivity and resource use efficiency both in field and fruit crops. Both water quantity and nutrients contained in urban and peri-urban waste waters make them attractive alternative water source for agriculture and aquaculture. Treated waste water from off-site treatment plants can be reused for irrigation of parks and gardens, agriculture and horticulture.

ii. ***Promoting Greenhouse and Plasticulture:*** The green-house technology and use of plasticulture using drip system of irrigation along with fertigation is one of the most modern technologies at present to grow high value crops with remarkable saving in water use. Greenhouse technology has been successfully used in the hilly, north and north eastern states as well as in states like Maharashtra and Karnataka. Utilization of plastic mulch along with drip line underneath has been very successful in controlling soil evaporation and water use by weeds. Studies have reported almost 30-40 per cent increase in yield of tomato by using straw and polythene mulch.

iii. ***Diversification and Intensification:*** Options for improving productivity and economic efficiency of water further lies in the production of timbers, agro-horticulture system, and growing of low water requiring medicinal plants as intercrops or sole crops. In the State of Madhya Pradesh, different medicinal plants grown in agro-forestry/ agro-horticulture system gave very high cost-benefit ratio.

iv. ***Integrated Farming System:*** Integrated farming systems are more productive, profitable and sustainable. Water conservation based models by integrating field and horticultural crops + livestock + biogas plants is quite prevalent in several parts of India. These practices do help in better resource utilization, generation, livelihood security and welfare of small land holders for holistic rural development. Also attention is needed to help the farmers in value addition, processing and marketing.

8. The Indian Oilseed Scenario: Challenges and Opportunities

Vegetable oils are critical for the nutritional security of people in India which occupies a prominent place in global oilseeds scenario with 12-15 per cent of area, 6-7

per cent of vegetable oil production, 9-10 per cent of the total edible oil consumption and 13.6 per cent of vegetable oil imports. India has rich diversity of annual oilseed crops. Despite having the largest area under oilseeds in the world (26.77 m ha), India currently imports about 50 per cent of total oil requirement at a huge cost of Rs.56,000 crore (2011-12).

Production Scenario

India attained an average productivity of 1,087 kg per hectare for the triennium ending 2012-13. The average yields of most of the oilseeds are invariably low The production scenario of vegetable oilseed sector in the country can be categorized into four periods, viz., i) Post Independence (1950 - 1966), ii) Coordinated Research Program (1967 - 1985), iii) Technology Mission (1986 - 1996) and iv) Post-Mission (1996-97 till date).

- ***Post Independence Period:*** This period witnessed mainly an area expansion The area increased by 32 per cent while the production increased by 34 per cent with negligible gain in productivity The growth rate of productivity was a meagre 0.07 per cent
- ***Coordinated Research Program Period:*** This period witnessed massive structural reforms in the national network in oilseeds. The area, production and productivity increased by 18, 41 and 19 per cent, respectively for the quinquennium ending 1985-86 as against that ending 1971-72.
- ***Technology Mission Period:*** Technology Mission on Oilseeds was initiated by the Late Hon'ble Prime Minister Shri Rajiv Gandhi in May 1986, with very ambitious objectives of (a) self-reliance in edible oils by 1990 (b) reduction in imports to almost zero by 1990 and (c) raise oilseed production to 18.0 million tons by 1989-90 and 26.0 million tons of oilseeds and 8.0 million tons of vegetable oil by 2000 AD. The mission started functioning as a consortium of concerned Govt. departments, The implementation of Technology Mission on Oilseeds spearheaded by Dr. M.V. Rao, resulted in the country's oilseed production surpassing the target of 18 mt, fixed for the Seventh Five-Year Plan. The import got reduced to almost negligible. Hence, India achieved near self-sufficiency in edible oils during early 1990s, which was popularly referred to as "Yellow Revolution". This golden era witnessed the release of 200 varieties and hybrids. As a result, India achieved a status of being 'self sufficient and net exporter' during early nineties, rising from the 'net importer' state.
- ***Post Mission Period:*** Government's economic policy allowed competition dominated by both domestic and multinational players. At the same time, the increasing per capita income led to enhanced consumption of edible oils. The gap between the domestic production and the requirement became widened at an alarming rate. This completely eroded the gains. In addition, the increasing biotic and abiotic stresses, strong intervention of market and non-market forces led to a sticky domestic oilseeds production and

profitability. Despite the above developments, performance of oilseeds on the domestic front during the last two decades has been commendable. The trend of vegetable oils production over the years did help to a considerable extent in reducing imports.

Demand, Import and Export Scenario

- ***Demand Projections:*** The domestic demand for vegetable oils has also been rising rapidly due to increase in per capita income and increase in standard of living. While our domestic output has been increasing at just about 2 per cent. Import bill thus began to increase at an alarming rate. On the export scenario of edible oilseeds and the products, the rate of growth was a meager four per cent. Need for a special oilseed mission to increase the domestic production of edible oilseeds, to combat the swelling import of edible oils, is being felt. The demand for vegetable oils is both income and price elastic. Demand for vegetable oil increases with increase in population, increase in standard of living and increased use for industrial, pharmaceutical, nutraceutical, and cosmetic purposes. The total vegetable oil requirement is thus to be met through domestic production. The country is meeting now more than 50 per cent of its oil requirement through imports resulting in huge drain on our foreign exchange.
- ***Export Trend:*** India made excellent inroads through export of oil meals (especially soymeal) and castor oil to the tune of Rs. 23,000 crore thus plugging almost 50 per cent of the import bill. The advantage of exports can further be consolidated with proper policy back-up and value addition.

Future Road Map

- ***Policy Issues Needing Perspective Changes:*** We need forward looking policies on mitigation of various kinds of risks in oilseed production efficiency and profitability to ensure healthy oilseed economy. All options for risk mitigation like linking farmers to market, buffer stock options, and other commodity price need to be put in place for oilseeds sector as a matter of priority.
- ***Trade-related Policy Initiatives:*** Government of India, with a view to meet the demand of edible oils and to control the rise in prices, has been allowing import of edible oils. All imports of edible oils meals were totally channelized through governments for sale through the Public Distribution System. India has become a major exporter of oilseed meals, especially soymeal. Indian oil meals command a premium because of its non-GM nature. Soymeal export is currently of US$ 2 billion annually.
- ***Support Price:*** Under the harsh growing conditions faced by Indian agriculture, oilseeds have a clear edge over many minor millets and pulses in terms of higher productivity. Unfortunately, the support price declared each year by the Government of India is evidently in clear favor of rice and

wheat compared to oilseeds. Similar consideration for oilseeds is therefore, warranted.

- ***Need for Institutional Linkages:*** Apart from the institutions as such, some institutional support programs (National Dairy Development Board, National Agricultural Marketing Federation and the flagship program of the government in oilseed sector; Integrated Scheme on Oilseeds, Pulses, Oilpalm and Maize) have been tried in the past. These programs need to be studied for understanding their significance and impact so that efficient and functional institutional support is provided in future for the required growth of oilseeds sector.
- ***Eco-regional Approach for Productivity Enhancement:*** The concept of eco-regional approach refers to the practice of delineating efficient zones for specific crops for realizing potential yields with high input-use efficiency. Concerted efforts on two categories of crop-wise eco-regions, viz., high area – low productivity and low area – high productivity zones will enhance efficiency in our efforts to increase production and productivity of oilseed crops.
- ***Natural Resource Management:*** Correcting the present limitation and imbalance in soil nutrients can provide rich dividends. Declining per capita arable land and extending oilseeds cultivation to poor and marginal soils result in low productivity. Precision crop management with conservation agricultural practices and customized fertilizer application schedules would usher higher efficiency and profitability. Emphasis on integrated natural resource management in oilseeds should, therefore, be our high priority.
- ***Crop Improvement Strategy:*** The gains in productivity of oilseed crops have been achieved primarily through exploitation of available genetic variability. Conventional breeding coupled with modern tools such as biotechnology should now be the primary focus in crop improvement programs.
    - ***Role of Biotechnology:*** At present, biotechnological research on minor oilseed crops (safflower, castor, niger, sesame, linseed and sunflower) is in its infancy. Therefore, it is essential to initiate concerted efforts using tools of biotechnology in these crops.
    - ***Transgenic Approach:*** There has been considerable progress towards harnessing transgenic technology for oilseed improvement. The transgenic technology has removed the phylogenetic barriers for transfer of useful genes across organisms. Modifying the fatty acid profile of the oil to suit industrial, pharmaceutical, nutritional, requirements using genetic engineering approaches has been a priority in application of biotechnology in oilseed crops. Transgenic technology, is facing stiff-resistance from a section of the society. It is the responsibility of scientists, policy makers, to allay the fears in public mind through scientific knowledge.
    - ***Exploring Frontier Sciences:*** Significant innovations in frontier science and technologies such as nanotechnology, genetic engineering and

biotechnology, hydroponics, vertical farming protected agriculture; precision agriculture provide unlimited opportunities for supporting higher production and product development. Oilseeds production will also benefit from innovations in industrial sector. These frontier sciences will have to be harnessed into ongoing research programs for productivity improvement.

- ***Public-Private Partnership and Linkages:*** The potential of public-private partnership through linkages in all aspects of oilseeds production and marketing needs to be harnessed for a win-win situation. The grey areas for PPP in oilseeds include incentives for seed production, forward/backward linkages for processing, value addition, contract research in niche areas, contract farming, joint ventures for higher order derivatives and speciality products, etc.
- ***Diversification and Value Addition:*** Designer oils with requisite blends can meet the expectation and to that extent of individual oilseed crop's potential. As for unique non-oil value aspects for specific aroma or non-oil uses (medicinal, ornamental or other uses), the individual oilseed crops would be grown for speciality purpose irrespective of productivity level. Major opportunities for oilseed crop diversification and value addition include introduction as catch crop in paddy fallows
- ***Adaptation to Climate Change:*** The low productivity and uncertain production of oilseeds is mainly due to their cultivation under rainfed conditions (about 70%). Oilseeds production is constrained by several biotic stresses like insect pests and diseases that are being further aggravated by changing climatic conditions. Global warming induced climate change is expected to trigger major changes in population dynamics of pests, and their biotypes. There is a need to generate information on the likely effects of climate change on pests so as to develop robust technologies that will be effective.
- ***Transfer of Technology:*** Concerted efforts are urgently needed for the dissemination of technologies on a participatory mode to be strengthened for effective delivery. The Farmer-Institution- Industry linkage mechanism should be strengthened The potential information and communication technology should be harnessed on a dynamic and interactive mode. This can minimize the dissemination loss while sharing information and provide benefits to all the stakeholders involved in oilseeds. Other specific recommendations to achieve these objectives have been spelt out.

The success of 'Yellow Revolution', achieved through mission mode approach of TMOP during eighties, fully justifies revival of Oilseeds Mission approach with greater zeal and commitment of all to tide over the present crisis of large scale import of edible oils. Hence, we must have clear national policy of bridging the yield gaps and increased oilseeds production with specific aim to reduce our vegetable oil imports.

9. Need for Linking Research with Extension for Accelerated Agricultural Growth in Asia

The Asia region is agriculturally vibrant. With 38 per cent of total agricultural land, it houses 80 per cent smallholder farmers supporting 74 per cent of world's agricultural population. It accounts for about 58 per cent of the world's population and is the largest supplier of the world's food and agricultural products and has witnessed "Green Revolution" brought out by a science-led synergistic extension approach capitalizing genetic potential, irrigation, fertilizer, appropriate policies and farmers' hard work. The increased agricultural productivity, resulted in quadrupling per caput GDP, thus almost halving the level of poverty in the region. However, continuing to secure such gains is becoming a major challenge especially in the context of declining factor productivity, deteriorating natural resources, impact of global climate change and above all a fatigue in the existing extension system.

Challenges: The problem has further been intensified with sharp rise in the cost of food and energy, depleting water resources, diversion of human capital from agriculture, shrinking farm size, soil degradation, imbalanced use of chemical inputs and overarching effects of changing climate. The region's agrarian landscape is predominantly smallholder farmers. It is estimated that by 2050, the food grain requirement in the Asia region would be around 70 per cent more than the current demand. Therefore, ensuring the availability of food, in both quantity and quality for the poorest of the poor remains a daunting challenge. In this context, the 'GCARD Road Map' which highlights the urgent changes required in Agricultural Research for Development (AR4D) is very important. The reduction in water availability and increase in animal and plant diseases will primarily affect poor countries.

Opportunities: Our rich genetic resources serve as a gold mine for specific/unique traits to be harnessed for germplasm improvement, through breeding and biotechnology to develop varieties/breeds possessing high productivity. Accordingly, germplasm conservation will significantly help in achieving both sustainable agricultural growth and development in Asia. It is, therefore, necessary to build an effective national agricultural research system (NARS).

Innovations around good agricultural practices such as: conservation agriculture (CA), balanced use of fertilizers, small farm mechanization, micro-irrigation, integrated pest management, scientific land use for crop diversification, etc. would contribute considerably in arresting natural degradation.

This region also has huge potential to promote horticulture. There is need to diversify the food basket by producing more of vegetables and fruits, preventing post-harvest losses and adopting food processing technology.

Mechanization and automation of dairy farms, measures to provide good quality feed and fodder, provision of improved seed varieties for fodder crops, value addition

of milk and meat products are some of the measures to enhance livestock industry. Fishery is another potential sector which can help in achieving both food and nutritional security. The inland fish farms with adoption of modern technologies, managed by skilled human resource can make all the difference.

Inclusive growth in agriculture through large scale adoption of new technologies, a major paradigm shift in our approach should be from R&D to AR4D, involving greater participation of all stakeholders. Regional partnerships are important to catalyze faster adoption of new technologies through sharing of success stories.

Linking Research with Extension: Our research should be sensitive to local needs and should meet the aspirations of both farmers and consumers. In India, the agricultural institutions (ICAR Institutes & SAUs) in collaboration with Department of Agriculture take part in technology generation and its transfer to stakeholders. Efforts are needed to capture farmer led innovations in agricultural practices and blend them with modern science through refinement. Agriculture is the only enterprise where prices are determined by others than the producer. To ensure competitive price of produce, role of middlemen has to be minimized and market forecasting systems have to be strengthened.

There is need to have a relook on domestic Agriculture Policy in order to make it more effective for infrastructure development, risk management and easy credit availability. Technologies relevant to women farmers need to be evolved and promoted to remove their drudgery.

Asia can reap the demographic dividend if attention is paid to create more and better jobs to retain youth in agriculture who have lost their interest in this profession. In this context, new opportunities are emerging in IT linked agri-extension, seed technology, biotechnology, food processing, cold storage, packaging, supply chain management, insurance and farm credit.

The success of Green Revolution was mainly due to holy alliance between researchers, extension specialists and the farmers.

A paradigm shift is needed from present national agricultural research institute (NARI) system to that of the national agricultural research and extension system (NARES) by having effective involvement of all stakeholders (researchers, extension personals, NGOs, Private Sector and the farmers).

The future AR4D efforts by NARS must now be reoriented towards farming system approach involving farmers' participatory approach.

7 Dr. M.S. Swaminathan Award for Leadership in Agriculture

The Trust for Advancement of Agricultural Sciences (TAAS) has instituted an award in honor of the renowned agricultural scientist Dr. M.S. Swaminathan, whose pioneering contributions to Indian agriculture had led to the Green Revolution in the late 1960s resulting in food self-sufficiency in India and neighboring countries.The award is given annually to an eminent scientist (either from India or abroad) for his/her outstanding leadership qualities in agriculture as demonstrated by significant contributions made towards overall agricultural growth in the developing world, especially in India. TAAS has conferred seven such awards already and the eighth one will be conferred in the later half of 2015. Details of distinguished recipients are given below while their citations are given at Annexure 7.

First Award

The first award was given to Nobel Laureate for Peace Dr. Norman E. Borlaug, the only agricultural scientist to have received this honor for his work on wheat

H.E. the President of India, Dr. A.P.J. Abdul Kalam presenting 1st award to Dr. Norman E. Borlaug

improvement at the International Maize and Wheat Improvement Center (CIMMYT), Mexico. His high yielding dwarf wheat varieties resulted in Green Revolution in India and other developing countries in mid-sixties when there was acute food scarcity. This award was presented to Dr. Borlaug by the then Hon'ble President of India, Dr. A.P.J. Abdul Kalam on March 15, 2005 at Vigyan Bhawan, New Delhi. (Citation is in Annexure 7)

Second Award

The second award was given to renowned rice breeder, Dr. G.S. Khush, the recipient of world Food Prize, by the Hon'ble Prime Minister of India, Dr. Manmohan Singh at Vigyan Bhavan, on October 9, 2006. Dr. Khush, while working at the International Rice Research Institute (IRRI), Manila was responsible for the development of more than 300 high yielding rice varieties which gave tremendous boost to productivity of rice in rice growing countries, resulting in increased rice production in Asia.(Citation is in Annexure 7)

Hon'ble Prime Minister of India Dr. Manmohan Singh presenting 2nd award to Dr. G.S. Khush

Third Award

The third award was presented to Dr. S.K. Vasal, an accomplished maize breeder, by Prof. M.G.K. Menon, Former Member, Planning Commission on May 3, 2008, at

Prof. M.G.K. Menon, Former Member, Planning Commission presenting 3rd award to Dr. S.K. Vasal

Shinde Auditorium, NASC Complex, New Delhi. Dr. Vasal's work at CIMMYT, on maize, led to the development of protein rich maize, known as Quality Protein Maize (QPM), which has resulted in nutritional improvement of several million people in the developing world. In recognition of outstanding work, Dr. Vasal received the World Food Prize in 1996. (Citation is in Annexure 7)

Fourth Award

The fourth award in the series was given to Prof. Rattan Lal, an eminent soil

Hon'ble Dr. Montek Singh Ahluwalia, Dy. Chairman, Planning Commission presenting 4th award to Prof. Ratan Lal

scientist from Ohio State University (OSU), for his outstanding contributions in the field of sustainable management of natural resources. His contributions have made great impact on food production through better soil management by the resource-poor farmers of developing courtiers. This award was presented to Prof. Rattan Lal by Dr. Montek Singh Ahluwalia, Deputy Chairman, Planning Commission on August 11, 2009 at Dr. BP Pal Auditorium, New Delhi. (Citation is in Annexure 7)

Fifth Award

The fifth award was presented to Dr. Sanjay Rajaram, a distinguished wheat breeder. His work at CIMMYT led to the development of improved wheat varieties which have been released in more than 50 countries, including around 25 in India. These varieties have helped in increasing wheat production in many developing countries. This award was presented by Dr. A.P.J. Abdul Kalam, former Hon'ble President of India on December 10, 2010 at Shinde Auditorium, NASC Complex, New Delhi. (Citation is in Annexure 7)

Former H.E. President of India Dr. A.P.J. Abdul Kalam presenting 5th award to Dr. Sanjay Rajaram

Sixth Award

The sixth award was presented to Dr. M.C. Saxena, an eminent agronomist and crop physiologist whose work on food legumes at International Center for

Former H.E. the Governor of Madhya Pradesh & Former Union Minister of Agriculture Dr. Balram Jakhar presenting 6th award to Dr. M.C. Saxena

Agricultural Research in Dryland Areas (ICARDA) has enormously benefited the resource poor farmers in West Asia, North Africa, Central Asia (CWANA) and South Asia, particularly Bangladesh, India, Nepal and Pakistan. His seminal work has helped in increasing the pulse productivity in these countries. This award was presented by Dr. Balram Jakhar, former Union Minister of Agriculture and H.E. the Governor of Madhya Pradesh on January 25, 2012 at Dr. BP Pal Auditorium, IARI, New Delhi. (Citation is in Annexure 7)

Seventh Award

The seventh award was presented to Dr. William D. Dar by Dr. K. Kasturirangan, Member, Planning Commission on June 24, 2013, at Dr. BP Pal Auditorium, IARI, New Delhi for his outstanding contributions towards food security and agricultural sustainability in Asia and Sub-Saharan Africa. The work done by him in the capacity of Director General, ICRISAT, has created considerable impact on resource poor farmers. Dr. Dar is well known for his efforts to promote public-private partnership and for inclusive market oriented development (IMOD). (Citation is included in Annexure 7)

Hon'ble Dr. K. Kasturirangan, Member, Planning Commission presenting 7th award to Dr. William Dar

Eighth Award

The eighth award is planned to be given to Dr. Thomas Lumpkin, Former Director General of CIMMYT on 28th September, 2015. Dr. M.S. Swaminathan will be the Chief Guest for the function.

8 Overall Achievements and Impact of TAAS

The recommendations emerging out of the discussions held during various symposia/ workshops/ seminars/brainstorming sessions have been forwarded from time to time to the concerned Government Departments/Ministries and other relevant organizations/agencies. It is encouraging that most of the recommendations have been received well and appropriate actions have been taken for their implementation. In the process, during the last one decade, TAAS as a 'Think Tank', has been able to catalyze the process of either creating an enabling policy environment or generating much required public awareness on issues of national importance. Following is a brief description highlighting the evident impact emerging out of TAAS initiatives:

1. Policy Advocacy

- For effective coordination and convergence of all agrobiodiversity related matters, the suggestion of a National Advisory Board on Genetic Resources Management got implemented by the ICAR. The high level board has taken steps to establish guidelines for managing plant, animal, fish, insects and microbial genetic resources by the respective Bureaus and has come out with an agreed material transfer agreement (MTA) format to transfer/share germplasm with all stakeholders concerned.
- TAAS could raise the concern in 2005 to catalyze and accelerate the process of establishing an office of Protection of Plant Variety and Farmers Rights Authority, which was getting considerably delayed though the Act was approved by the Parliament in 2001. Also the creation of Gene Fund was emphasized which could support the farming communities engaged in *in situ* conservation of valuable genetic resources. The Authority office was established in 2006 and the Gene Fund is now functional. Also, the process of registration of Farmer's Varieties has taken considerable headway while awareness generation campaigns by the authority as well as other concerned agencies are in full swing.
- The promotion of hybrids/HYVs in major field crops was emphasized to increase productivity through creation of a "Seed Mission" at the national level with better coordination and convergence of public and private seed organizations for faster growth, including rolling plan for 5 years in each State to ensure availability of good quality seed for higher replacement ratio

in important crops. Accordingly, the Planning Commission had decided to create a Seed Mission in the 12th Plan period.

- The urgency for getting the approval for revised Seed Act has received due consideration of the Ministry of Agriculture. The draft Act has presently been tabled before the Parliament for its approval. Once approved, after addressing the difficulties pointed out from various concerned quarters, it is expected that the seed development related activities would get accelerated with needed provisions and incentives for quality seed production.
- Emphasis on increasing the seed replacement rate under hybrids of important crops, including vegetables, for increasing their productivity has been appreciated. Accordingly, both public and private sectors are being encouraged to play their effective roles. Thus, the recommendation to provide similar incentives to private seed sector on par with public sector institutions especially for hybrid seed production, is under active consideration of the government.
- The inclusion of maize in the food security mission as well as promotion of quality protein maize (QPM) to address the problem of nutrition security has strongly been recommended for active consideration of policy planners and decision makers. Maize accordingly got included in the National Food Security Mission (NFSM) and efforts are on to double the maize production through higher coverage under high yielding single cross maize hybrids
- In view of malnutrition being a serious national problem, use of soybean as a food crop was strongly recommended to the Government to address on priority the acute protein deficiency problem in our young children. Accordingly, this recommendation is getting needed attention for use of soya milk and other products in the mid-day meal scheme of the government.
- For a single window clearance of regulatory processes relating to testing and release of GM crops, being a recommendation of the brainstorming session in 2003, the Department of Biotechnology took action to create a Biotechnology Regulatory Authority of India (BRAI).The BRAI Bill was, however, deferred by the Parliament and a fresh attempt by DBT needs to be made.
- Policy recommendation on 'khet ka pani khet mein' through promotion of farm development activities such as bunding, field leveling etc. has been considered for implementation for resource poor farmers under the existing national schemes such as MGNREGA, RKVY, etc.
- TAAS recommendations in the form of "Ranchi Declaration" have received due consideration by the ICAR and Department of Animal husbandry in preparing a clear roadmap for both preparation and implementation of a National Plan of Action on management and conservation of farm animal genetic resources. In this context, special focus is being laid on valuable indigenous breeds that need priority attention for both conservation and genetic enhancement. Also a "National Mission on Livestock" has been created under the 12th FYP to

accelerate livestock development in India. Further, to conserve and develop indigenous bovine breeds, the new government has launched a disruptive new initiative, the 'Rashtriya Gokul Mission' under the National Programme for Bovine Breeding and Dairy Development (NPBBD), which was launched in 2014 with an integrated, holistic and scientific approach to improve and upgrade the genetic makeup of bovines. Other objectives of the mission include enhancing their production and productivity, including developing and conserving indigenous breeds of milch cattle and development of dairy infrastructure for improved procurement, processing and marketing.

- Suggestion to modify APMC Act in order to reform the marketing system and to link farmers directly with consumers through inclusive market oriented development (IMOD) has been well received and some states have already taken positive steps to delink sale of vegetables and fruits, being of perishable nature, from APMC Act.
- Considering the dire need for building research management cadre of scientists, with an aim to accomplish 'servant leadership' goal, the recommendation to have both mid and senior level management orientation programs (EDP and MDP) at the National Academy of Agricultural Research Management (NAARM) have been implemented. Also, ICAR has taken a decision to make these courses mandatory for all research management positions.

2. Public Awareness

- TAAS has been regularly publishing several strategy papers/ lectures of eminent scientists and the proceedings of national seminars organized on subjects of national importance. These have been circulated to a number of stakeholders and special efforts have been made to create much needed public awareness on issues of immediate relevance. All these documents have been posted regularly on TAAS website for the benefit of scientists, farmers and other key stakeholders.
- On the basis of recommendations emerging out of a national dialogue on improving soil health conditions, needed public awareness concerning the conservation and sustainable use of natural resources, such as land, water and agrobiodiversity has been created for increased production, profitability, environmental sustainability and improved livelihood of smallholder farmers.
- The scientists, policy makers, farmers and other stakeholders have been sensitized through national debate towards sustainable diversification of agriculture through reorientation towards "farming systems' mode" by integrating crops, livestock, and fisheries to improve both farm productivity and profitability. Also awareness about soil test based use of fertilizers to overcome existing imbalance of nutrients/micro-nutrients in the soil has helped in ensuring rational use of need based nutrients/fertilizers.

- Urgent need has been stressed for out-scaling the innovations that save inputs and enhance income of the farmers such as: conservation agriculture, plastic mulching, direct seeding of rice, alternate furrow irrigation, micro-irrigation, fertigation, IPM etc. Also, attention of policy makers has been drawn towards faster adoption of small farm mechanization for achieving much needed resilience in agriculture.
- Necessary knowledge has been disseminated and awareness created about the judicious use of water through required pricing of water and agricultural diversification through scientific land use planning involving crops, horticulture, agro-forestry and silvi-pastoral approaches and promotion of micro-irrigation systems in place of existing practice of flood irrigation for improved water-use efficiency.
- TAAS was instrumental in organizing the first ever Global Conference on Women in Agriculture with participation of 760 delegates from more than 37 countries. Through this, the specific problems of women engaged in agriculture were emphasized and suitable strategies suggested to overcome their drudgery in farm operations through appropriate technological interventions, engendering (through capacity building) and empowering them with in-depth knowledge, legal rights, needed policies and proper incentives. It also became evident that empowering farm women will not only help in increasing farm production by almost 20 per cent but would ensure household nutrition security being a major concern in the present context.
- Considering the current challenge of retaining youth in agriculture, TAAS could catalyze the National Agricultural Research System (NARS), especially the ICAR, to engage youth in agriculture and evolve progressive strategies to attract them towards secondary/ specialty agriculture by ensuring much needed vocational training and bank credits. The proposal to make them technology agents/service providers and/or input/implement providers, entrepreneurs for value addition and primary processing and also for linking farmers to market is currently receiving due attention of policy/decision makers.
- The researchers, policy makers, and development officials have been sensitized to up-scale and out-scale farmer led innovations, which are cost-effective, sustainable and useful to them for increasing both production and profitability. Also efforts are now on to create an Agriculture Innovation Fund by the ICAR so as to scientifically validate and promote large scale adoption of useful technologies as well as to train enterprising farmers, especially the women and youth.
- In order to address the concerns of farmers, some of the states have already been catalyzed to establish Farmers' Commission and take progressive steps to come out with state agriculture policies.
- For open access to knowledge, which farmers need urgently, a National Agriculture Information System (NAIS) is being created and efforts are on

to provide need based knowledge to the farming community through use of ICT, smart phones and media. In this context, long standing recommendation of TAAS for a dedicated TV channel on agriculture has now recently been made effective so that farmer gets much need timely knowledge on all aspects from 'plough to plate'.

- In order to address effectively the adverse effects of climate change and also the weather related calamities, the recommendations to promote climate smart agriculture, crop as well as livestock insurance, seed banks, credit at low interest, immediate compensation using GIS based weather data and on the spot quick assessment are being considered critical to redress the grievances of small holder farmers.
- Importance of increasing wheat production to a level of 100 mt by 2015 was emphasized through a dialogue in 2010 and a Roadmap drawn to catalyze the system. Accordingly, pushing aside the setback to crop due to weather aberrations in several states, this goal is likely to be achieved well within time.
- Awareness about importance and relevance of GM crops for Indian agriculture has been created through national dialogue and relevant publications. Efforts have also been made to change the public perception based on scientific reasoning and informed knowledge concerning the benefits of technology to both farmers and consumers. Also the need for efficient regulatory system and specific role of ICAR in the conduct of confined field trials and ultimate release of GM crops for general cultivation in the national interest has been emphasized. Accordingly, the needed steps have now been taken in this regard by both DBT and ICAR.
- Also, the process of public-private-partnership has been catalyzed to ensure quick delivery of results to the end users. Accordingly, some institutions and universities have taken up steps for building public-private partnerships for out scaling innovations. As such, different models of PPP have been put in place.
- Awareness concerning use of soybean as a food crop to overcome protein malnutrition, being very important concern in India, has been generated. Also its use through various food products (flour, tofu, milk, oil, puffs, biscuits, ice cream etc.) through promotion of small scale industry and producer companies has been advocated, for which role of research institutions/universities/KVKs has been highlighted. Also the need for the creation of a Soybean Board has been emphasized.

Outcome of various TAAS activities organized

- An initial idea may be gathered from Box-4 below whereas some more details are provided in section 5. Overall, the impact of the Think-Tank process initiated by TAAS has been highly visible at national, regional and global levels, and worth sustaining the efforts by strengthening the TAAS.

Box 4: Highlights of impact based on TAAS recommendations

1. The Protection of Plant Varieties and Farmers Rights Act, 2001 was passed by the Parliament and the same is being implemented. The process for creation of office and proper functioning of PPV&FRA was also accelerated by DAC when urgency for same was highlighted especially when it was getting delayed for more than 5 years after the approval of PPV&FRA. Also a Seed Mission has been launched in the 12th Plan by the Government to improve crop productivity.
2. The Revised Seed Bill was introduced by Department of Agriculture and Cooperation (DAC) in the Parliament on December 9, 2004 and subsequently amended on November 9, 2010. Same as under consideration for approval.
3. Necessary action has been taken by the Department of Biotechnology (DBT) to establish a Biotechnology Regulatory Authority of India (BRAI) as a single window clearance system for GM crops. The Bill introduced in the Parliament on April 22, 2013, awaiting now the approval.
4. A National Advisory Board on Genetic Resource Management was created by Indian Council of Agricultural Research (ICAR) to provide oversight function for managing valuable genetic resource in the year 2011 under the Chairmanship of Dr. R.S. Paroda and Co-Chairmanship of Dr. S. Ayyappan. The Board has accelerated the process of establishing guidelines for managing our valuable genetic resources of plants, animals, fishes, agriculturally important insects and microbes. Also for the Access and Benefit Sharing (ABS), a Standard Material Transfer Agreement (SMTA) has been finalized for sharing the germplasm with both public and private sector.
5. Maize has been included in the Food Security Mission by the DAC based on strong recommendations made by TAAS. Accordingly, maize production is showing highest growth rate now among cereals.
6. Efforts have been accelerated to promote Public-Private Partnership (PPP) by ICAR and the State Agricultural Universities (SAU) for non-exclusive licensing of innovations in agriculture.
7. Open access for knowledge sharing to the farmers through ICT and other communication means has been given high priority both by DAC and ICAR. The demand to have a dedicated channel for agriculture has recently been met by the Government.
8. The National Academy of Agricultural Research Management (NAARM) has initiated capacity development programs for both middle level and senior research management scientists. These are i) launching of executive development program (EDP) and ii) management development program (MDP) for the middle level and senior research management cadres.

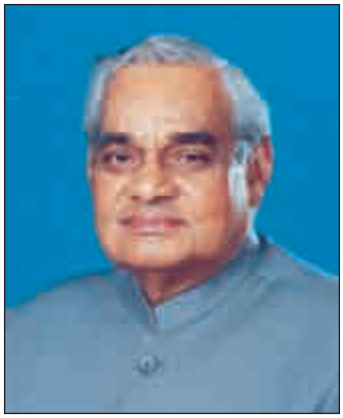
9. Some States have taken progressive steps to establish State Farmers' Commission for addressing the concerns of farmers and to provide needed incentives for out-scaling innovations for improving their livelihood.
10. Promoting soybean as a food crop and to ensure nutritional security Necessary steps have been taken by the Government to promote soybean and quality protein maize (QPM) as food crops to address the major current concern of protein malnutrition of children below 5 years of age.
11. To accelerate growth of animal sector and to ensure genetic enhancement of indigenous livestock breeds, Ministry of Agriculture has launched a Livestock Mission under the 12 Five Year Plan.
12. In order to link farmers to market, the APMC Act is being revised by the State Governments especially to delink perishable items such as vegetables, fruits and flowers.

9 Publications

1. Recommendations of Brainstorming Workshop on "Up-scaling Quality Protein Maize (QPM) for Nutrition Security", May 20-21, 2015.
2. Strategy Paper on "Need for Linking Research with Extension for Accelerated Agricultural Growth in Asia" by Dr. R.S. Paroda. September 25, 2014.
3. The Eighth Foundation Day Lecture on "Sustainable Agricultural Development – IFAD's Experiences" by Kanayo F. Nwanze, President, IFAD, August 5, 2014.
4. Recommendations of Brainstorming Workshop on "Soybean for Household Food and Nutrition Security", March 21-22, 2014.
5. Proceedings of Brainstorming Workshop on "Strategy for Conservation and Productivity Enhancement of Farm Animal Genetic Resources", January 10, 2014
6. Proceedings and Recommendations of National Workshop on "Outscaling Farm Innovation", September 3-5, 2013.
7. Strategy Paper on "The Indian Oilseed Scenario: Challenges and Opportunities" by Dr. R.S. Paroda. August 24, 2013.
8. Proceedings and Recommendations of Brainstorming on "Achieving Inclusive Growth by linking Farmers to Markets, June 24, 2013.
9. A Brief report of Dr. Swaminathan Award function, June 24, 2013.
10. Strategy Paper on "Managing our Water Resource for Increased Efficiency" by Dr. R.S. Paroda, May 28, 2013.
11. Proceedings and recommendations of "Foresight and Future Pathways of Agricultural Research through Youth", March 1-2, 2013.
12. Special lecture delivered at Indian Seed Congress 2013 on "Indian Seed Sector: The Way Forward" by Dr. R.S. Paroda, February 8, 2013.
13. The Seventh Foundation Day Lecture on "Ensuring Food and Nutrition Security in Asia: The Role of Agricultural Innovation" by Dr. Shenggen Fan, DG, IFPRI, January 11, 2013.
14. Proceedings and Recommendations of Global Conference on "Women in Agriculture", March 13-15, 2012.
15. The Sixth Dr. M.S. Swaminathan Award Lecture on "Challenges and Opportunities for Food Legume Research and Development" by Dr. M.C. Saxena, January 25, 2012.

16. Strategy Paper on "Implementing the International Treaty to Address Current Concerns about Managing our Plant Genetic Resources" by Dr. R.S. Paroda, January 23, 2012.
17. Proceedings of Farmers' Led-Innovation, December 23-24, 2011.
18. Proceedings of International Conference on "Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences", November 9-12, 2011
19. TAAS Foundation Day Lecture on "Harnessing Knowledge for India's Agricultural Development" by Dr. Uma Lele, August 12, 2011.
20. Recommendations of Stakeholders' Interface on GM Food Crops May 19, 2011.
21. Proceeding and Highlights of Brainstorming Session on Prospects of Producing 100 million tons of Wheat by 2015 and presentation of Fifth Dr. M.S. Swaminathan Award for leadership in Agriculture, December 18, 2010.
22. NSAI Foundation Day Lecture on "Revitalizing Indian Seed Sector for Accelerated Agricultural Growth", by Dr. R.S. Paroda, October 30, 2010.
23. Proceedings and Recommendations of National Dialogue on Building Leadership in Agricultural Research Management, Hyderabad, August 27 - 28, 2010.
24. TAAS Foundation Day Lecture on "Climate Change and Food Security: From Science to Sustainable Agriculture" by Dr. Mahendra M. Shah, May 7, 2010.
25. Proceedings and Recommendations of National Seminar on "Quality Seed for Food Security through Public-Private Partnership", April 13-14, 2010.
26. Millions Fed: Proven Successes in Agricultural Development jointly published by IFPRI, APAARI and TAAS, January 19, 2010.
27. Intensive Efforts Needed for Food and Nutrition Security - Strategy Paper by Dr. R.S. Paroda, November, 2009.
28. Imperatives of Global Climate Change for Agricultural Research in Asia-Pacific - Strategy Paper by Dr. R.S. Paroda, November, 2009.
29. Proceedings and Recommendations of Brainstorming Workshop on "Climate Change, Soil Quality and Food Security", August 11, 2009.
30. Ranchi Declaration - Brainstorming Workshop on 'Strategy for Conservation of Farm Animal Genetic Resources', 10th – 12th April, 2009.
31. Proceedings and Recommendations of Brainstorming Workshop on "Emerging Challenges before Indian Agriculture - The Way Forward", March 6, 2009.
32. Fourth Foundation Day Lecture on "Overcoming the World Food and Agriculture Crisis through Policy Change, Institutional Innovation and Science" delivered by Dr. Joachim von Braun, Director General, International Food Policy Research Institute, Washington, March 6, 2009.

33. Proceedings and Highlights of National Symposium on Quality Protein Maize for Human Nutritional Security and Development of Poultry Sector in India and Presentation of the Third Dr. M.S. Swaminathan Award for Leadership in Agriculture, May 3, 2008.
34. Proceedings of Symposium on "Farmer-Led Innovations for Sustainable Agriculture", December 14-15, 2007.
35. Highlights and Recommendations of Brainstorming Session on "Models of Public-Private Partnership in Agricultural Biotechnology ", April 7, 2007
36. Highlights and Recommendations of Farmer-Led Innovations Towards Plant Variety Improvement, Conservation and Protecting Farmers' Rights", November 12 - 13, 2006.
37. A brief report on the Second Dr. M.S. Swaminathan Award for Leadership in Agriculture, October 9, 2006.
38. Strategy for Increasing Productivity Growth Rate in Agriculture" - Strategy Paper by Dr. R.S. Paroda, August, 2006.
39. Highlights and Recommendations of Brainstorming Session of Farmer-Led Innovations for Increased Productivity, Value Addition and Income Generation, October 17, 2005.
40. Second Foundation Day Lecture on "Public-Private Partnership in Agricultural Biotechnology" delivered by Dr. Gurdev S. Khush, Adjunct Professor, University of California, Davis, USA, October 17, 2005.
41. Highlights of First Dr. M.S. Swaminathan Award for Leadership in Agriculture, March 15, 2005.
42. Recommendations of National Workshop on Role of Information Communication Technology in Taking Scientific Knowledge/Technologies to the End Users, January 10 - 11, 2005.
43. Highlights and Recommendations of Brainstorming Session on Role of Science and Society towards Plant Genetic Resources Management - Emerging Issues, January 7 - 8, 2005.
44. Special Lecture on Challenges in Developing Nutritionally Enhanced Stress Tolerant Germplasm delivered by Dr. S.K. Vasal, Distinguished Scientist, CIMMYT, Mexico, January 15, 2004.
45. Brainstorming Session on Enabling Regulatory Mechanisms for Release of Transgenic Crops, October 18, 2003.
46. First Foundation Day Lecture on Regulatory Measures for Utilizing Biotechnological Developments in Different Countries, delivered by Dr. Manju Sharma, Secretary, Department of Biotechnology, Government of India, October 17, 2003.



FORMER PRIME MINISTER OF INDIA | SHRI ATAL BIHARI VAJPAYEE

Speech

January 3, 2001, New Delhi

Prime Minister Shri Atal Bihari Vajpayee Inaugurates 88th Session of Indian Science Congress

The following is the text of the speech of the Prime Minister, Shri Atal Bihari Vajpayee at the inauguration of the 88th Session of Indian Science Congress here today:

It gives me great pleasure to participate in this important annual event of Indian science and be in the midst of a distinguished assembly of scientists. I convey my best wishes to all of you for the New Year that has just begun.

Of the many forces that will shape human history in the new millennium, science and technology will perhaps be the most potent. We know how science and technology have changed the complexion of the world in the last couple of centuries of the last millennium. But this is just the beginning of a long and exciting voyage. All the discoveries of science and all the inventions of technology so far amount to the arrival of just a couple of stars in a sky of countless stars that are yet to appear.

How true was Newton when he confessed, in spite of all his epochal discoveries, that he felt like a boy on the seashore who found just a pebble or a shell, whilst the great ocean of knowledge lay all undiscovered before him.

The sky of science belongs to the entire mankind. No part of it can be a monopoly of any single nation. That is how it should be. If science has the power to benefit man, then that power should be accessible to men all over the world. Nevertheless, every nation on this planet, and certainly a big and ancient nation like ours, is required to ask itself: 'How many stars in the sky of science have we caused to appear? How much have we contributed to the advance of scientific knowledge and to the betterment of life? And what plans have we drawn up for its progress in the future?'

Today we pay our tributes to all the visionaries of the past century who built a strong edifice of science and technology in India. We should pledge to not only strengthen the institutional base that they have created, but also to further expand it to make India a front-ranking scientific power in the new century.

Since the theme of your session is 'Food, Nutrition & Environmental Security', I cannot but remember with deepest gratitude and admiration the name of my friend, Bharat Ratna C. Subrahmaniam, who passed away recently. He, along with Dr. M.S. Swaminathan, who is in our midst today -- was the principal architect of the Green Revolution, which ensured India's self-reliance in food production. Subrahmaniam retained his interest in new developments in science and technology until the very end of his long life and used to regularly give me useful suggestions. India needs many more such top-class administrators with a multi-dimensional vision.

The theme of your session this year is most appropriate for it simultaneously impacts on many of India's critical developmental priorities. I compliment our hard-working kisans for steadily increasing the country's food production. Today we are facing a shortage not of food, but of facilities to store food. If India was able to withstand economic sanctions following Pokharan-II, a major part of the credit must go to our talented scientists, including our agriculture scientists.

Having achieved food sufficiency, our aim now is to achieve food security for all our citizens. The percentage of our population living below the poverty line has come down, and we have overcome starvation. Our objective now is to overcome malnutrition. The new century will be the Century of Knowledge and the Century of Mind. However, if the brain does not develop properly in nearly one-third of our children who are undernourished, how will we be able to create those young minds that are essential to build India of our dreams in the 21st century? More than 50 percent of the pregnant women and children are anaemic. Vitamin and protein deficiencies are rampant. These realities overshadow our achievements and burden our national conscience.

At another level, the increases in food production that we have achieved in the past 3-4 decades have come at a cost to the agricultural environment. There has been both qualitative and quantitative degradation of land, water, and bio-resources. I have seen fertile lands that have become uncultivable due to waterlogging and salinization. I have seen areas where yields have come down because of wrong cropping pattern and faulty usage of fertilisers. I have also seen how excessive pumping of water has caused such acute depletion of water table that even drinking water has become scarce.

Environmental security is, therefore, no longer peripheral to the issues of food and nutritional security. Neglecting it yesterday has proved costly today; and could prove far costlier tomorrow. We must, therefore, step up our programmes on soil and water management, renewable energy sources, forest management, containment of chemicals and other pollutants, waste management, and conservation of bio-diversity for sustainability of Indian agriculture.

I urge the participating scientists to come up with comprehensive and useful recommendations to deal effectively with all the issues relating to food, nutrition, and environmental security. Accomplishing this task requires massive efforts in many areas that range from increasing crop yields to improving rural infrastructure; preventing huge wastage and losses that now characterise our food economy.

The government has taken some steps in this direction. The ambitious national rural roads project, which aims at providing all-weather road connectivity to over one lakh unconnected villages in the country in the next seven years, is one of them. Another recent initiative in food security is the Antyodaya Anna Yojana, under which wheat and rice will be provided at Rs. 2 and Rs. 3 per kg respectively to one crore poorest of the poor families.

The Government has unveiled a National Storage Policy under which private sector investment is encouraged for the construction of modern silos at 20 locations to take care of buffer stocks. We shall soon initiate steps to restructure the Food Corporation of India in order to reduce costs and introduce greater efficiencies in the procurement, storage, and distribution of foodgrains. I recognise, however, that many more steps are necessary to resolve the long-neglected problems at all points in the food chain. Towards this end, the Government has recently set up a high-level inter-ministerial Group on the Food Economy to unlock its huge potential to create employment, generate wealth at the grassroots and boost our agricultural exports. The group, which is headed by the Finance Minister, will consult experts from various fields.

The task of ensuring food, nutrition, and environmental security in a vast country like India is gigantic. And not all solutions to the problem lie in science technology, although your contribution will certainly be invaluable. What is needed is a collective and coordinated action among all those who are associated with our agriculture and the rest of the food economy. We know that Mother Nature yields the best crop only when all the necessary conditions are properly fulfilled. Similarly, kisans and rural credit institutions, Agriculture Universities and Krishi Vigyan Kendras, meteorological offices and marketing cooperatives, all have to work in perfect concert for us to achieve best results in the task before us.

In this endeavour, we will have to fully mobilise the vast pool of our people's traditional wisdom and knowledge, just as we have to employ new frontiers of scientific knowledge such as information technology, bio-technology, space science, nuclear science and genetic engineering. We should not be afraid to experiment with bold ideas. Green Revolution, for example, would not have been successful if our scientists had yielded to the resistance they faced. We are now entering the era of what is called 'precision agriculture', which is knowledge-intensive and uses the latest that science has to offer. India should take the lead in this.

We also have to close the vast distance that still separates the scientist from the kisan. Despite some commendable efforts of the Indian Council of Agriculture

Research, 'Lab to Land' has still largely remained a nice-sounding slogan. I think that it needs to be supplemented with the reverse initiative of 'Land to Lab'.

For instance, I often wonder why there are so few facilities even for our most progressive farmers, who otherwise might have very little exposure to the formal educational system, to improve their theoretical and practical knowledge. If business executives and professionals can have short-term retraining courses specially designed for them, why not for our knowledge-hungry farmers? Lack of formalised agricultural education to practising farmers is, in my view, the weakest link in our farm strategy. There seems to be a well-entrenched misconception that a farmer needs no formal education in farm management. We must rectify this lacuna urgently to enrich the human resource in Indian agriculture.

Distinguished Scientists, let me now turn to some other critical issues before Indian science. During the last Science Congress Session in Pune, I had pledged that the Government would hike investments in R&D from the present level to 2% of GDP over the next five years. We have taken some specific steps in this direction, and many more will follow. The Finance Minister has earmarked Rs.50 crores for the India Millennium Missions to be executed by Technology Information, Forecasting and Assessment Council (TIFAC) and an additional Rs.50 crores for the New Millennium Technology Leadership Initiatives by CSIR. The message of these initiatives is clear and simple: India should be ahead of, and not lag behind, other nations in at least some areas of technology in the 21st century.

The challenges and opportunities of global competition in the emerging Knowledge Economy have placed a major task before the nation. It is the creation of a vast army of top-class professionals in science and technology, especially in information technology and bio-technology, to meet the demands of both the domestic and international markets. However, the ever-increasing demand for the Indian software professionals in India and abroad, along with the opening up of new career opportunities, has resulted in a lack of enthusiasm among young students for higher studies in science and careers in scientific research. Such a trend, if not arrested at this stage, may result in serious shortages of good quality teachers and research scientists.

To bridge this gap between demand and supply, the Government is seriously considering setting up a National Mission for Technology Education. It will aim to ramp up, on a crash basis, the facilities at IITs, RECs and other premier science and engineering colleges. It will also seek to bridge the gap between academia and industry on the one hand, and between teaching and research institutions on the other. To realise these objectives, we will take necessary measures to radically reform the governance structures of our higher education institutions and encourage the flow of philanthropic funds from alumni and the Indian Diaspora abroad.

In this context, I would like to make a special mention of the proposal by a group of highly successful Indian IT entrepreneurs in the United States to set up Global Institutes of Science and Technology. The Government will actively facilitate this and other such initiatives.

Removing the controls of bureaucrats is one of the pressing reforms needed to improve the governance structure of our research and higher education institutions. For Indian science to flourish, the administration and government officials should serve as facilitators of science and not as masters of scientists. I have said this before, but I feel it bears reiteration.

We need bold and unconventional initiatives also to seize the big new opportunities arising on the horizon. One of them is the information generated by the Human Genome Project in the open domain. It is now available to Indian scientists. Once the 'base' is established, it is the knowledge of 'variation' over the base that matters. India's vast human genetic diversity provides that knowledge, like no other country does. India already has a superb IT manpower and also people trained in biosciences. Thus, 'bioinformatics' is the next wave in which India should be in the vanguard. India caught up with the 'Silicon Valley' phenomenon rather late. Can we not create the new 'Genomic Valleys' of the twenty-first century?

I understand that these initiatives need huge investments, which cannot come from the traditional budgetary route alone. But the funding needs of Indian science can be adequately met by promoting an innovative public-private partnership. I am happy to note that the physical and intellectual infrastructure developed by the government at long last is being tapped by the Indian private sector to take a global lead. Indian businesses are beginning to respond to the opportunities in knowledge industry, rather than being oblivious to global S&T developments as in the past.

Distinguished Scientists, our goal to make India a leading scientific nation in the world in the new century hinges critically on how successfully we take science to the people and create a stronger scientific temper in our society. I appreciatively recall that last year's session at Pune turned out to not just 'Science Congress' but a 'People's Science Congress'. The 'Children's Science Congress', which was held simultaneously, was also a novel initiative. I am happy that this initiative has been taken forward by mobilising kisans in large numbers in this Session of the Indian Science Congress. I am sure that this trend will be further strengthened in the future.

With these words, I am happy to announce the formal inauguration of the 88th Session of the Indian Science Congress.

Thank you

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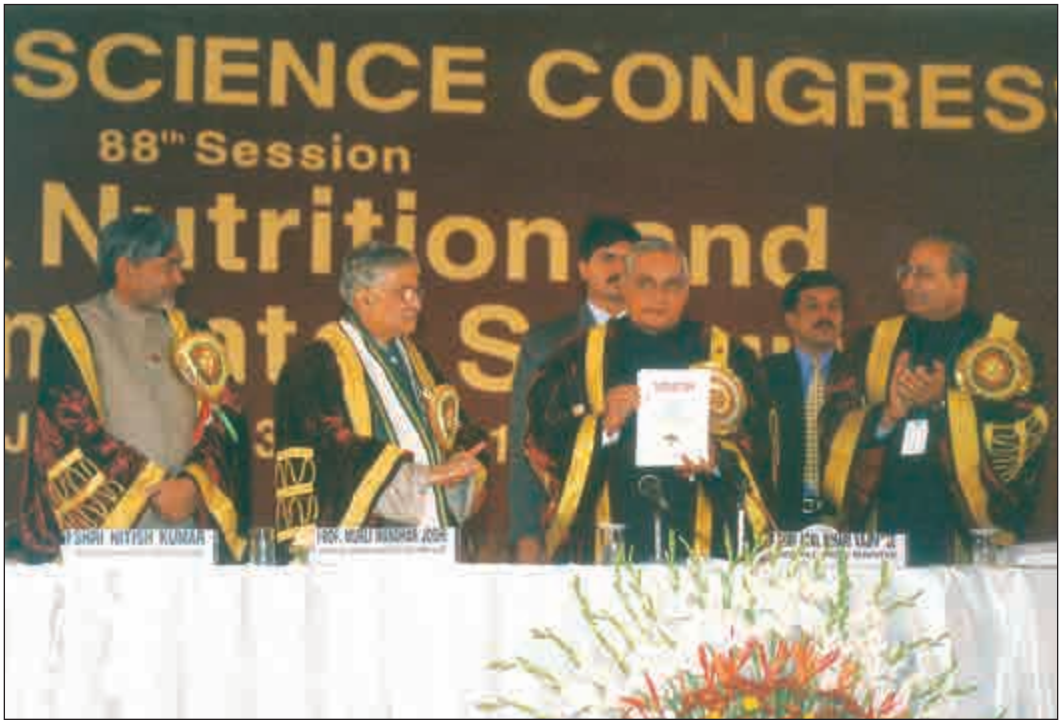
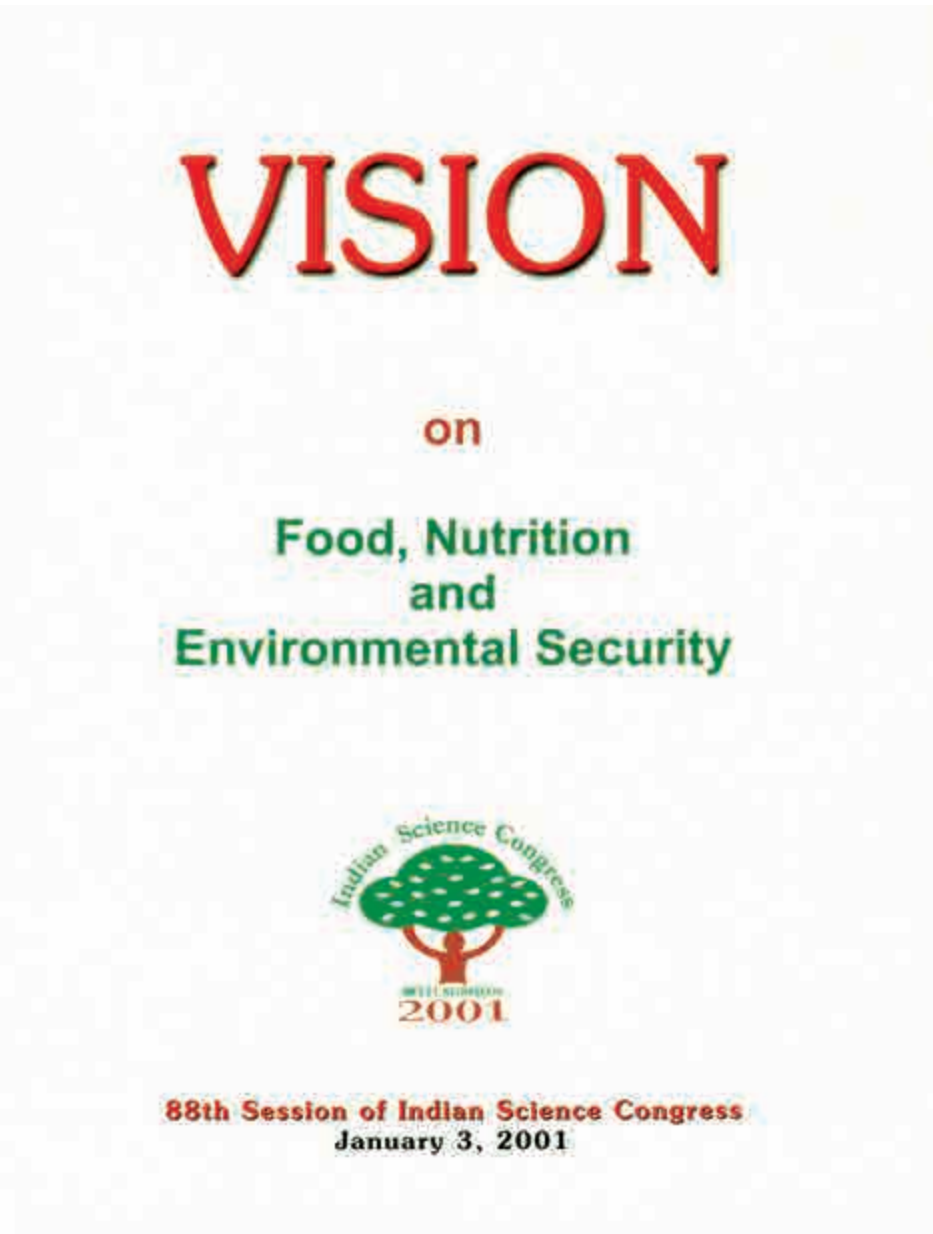

SCIENCE CONGRES
88th Session

Vision Document



VISION
on
Food, Nutrition and Environmental Security

Preamble

Achievements

Stepping into the 21st century, India can legitimately take pride in the remarkable progress it has achieved in every area of human endeavour over the last 50 years. Synergy between science, technology, organization and public policy, has helped bring about a sea change in the areas of agriculture, food, and the environment. Food grain production has increased four fold, to support a rapidly increasing population. Per capita income has doubled. There is an impressive increase in life expectancy and decline in infant mortality. Thanks to cutting-edge science and technology, India has moved from chronic shortages to an era of surpluses in most food products, erasing the memories of famine and mass starvation.

Inequities

However, problems particularly those relating to ecology, gender and social equity, employment, energy and economics continue to persist. Sizeable sections of the population–particularly labour households, in rural areas and urban slums, who lack resources and skills—are still illiterate, poor, and malnourished. Almost half of the children of pre-school age still suffer from moderate to severe malnutrition. More than 50% of pregnant women and children are anaemic. Every third child born in the country has low birth weight, running the risk of impaired health and brain development. Vitamin and micronutrient deficiencies are widespread. These realities overshadow the achievements, and weigh heavy on the national conscience.

Environment

Rising population, persisting poverty, rapid urbanization, industrialization, deforestation, intensification of agriculture, and lack of appropriate policies are putting enormous pressure on our natural resource base. This has led to both quantitative and qualitative degradation of land, water, air and bioresources, endangering the ecological foundations that are essential for sustainable advances in the productivity of major farming systems. The problems are compounded by dwindling non-renewable resources. In some areas, such degradation threatens even livelihood prospects.

Food, nutrition and environmental security cannot be attained without an immediate check on the runaway population growth. To keep pace with the changing trends, we need an extra 5 million tonnes of foodgrains annually, besides significant increases in the production of livestock, fish and

horticultural products. This has to be accomplished in the present scenario of declining total factor productivity growth, shrinking arable land and farm size, growing regional disparity, depleting natural resource base, increasing biotic and abiotic stresses, an outdated knowledge transfer system, and the likely adverse impact of global climate change. Availability of energy and good quality water to meet the rising overall demand would become critical in future. The slow growth of employment in the agriculture and other sectors threatens the income base and food entitlement of the poor. Health and education deficiencies, female illiteracy and gender inequities, and growing feminization further restrict both income and employment opportunities. Agriculture continues to lose ground to other professions considered more attractive by the younger generation. Declining capital investment and resource availability constrains the development of physical and social infrastructure, particularly in the rural sector. Domestic market imperfections, price volatility, food quality, and safety and phytosanitary concerns are critical. The World Trade Organization (WTO) and emerging Intellectual Property Rights (IPR) regime affect the free flow of advanced technology and knowledge. The globalization of markets will influence domestic production, employment and price stability. The country's trade prospects hinge on such factors as price competitiveness, quality, and consistency of supply. Another threat is the use of new kinds of barriers in the guise of food safety and social concerns.

Uncommon opportunities

India's strong institutional and human resource base in science and technology is fully capable of bringing about a technological transformation of agriculture, paving the way for an ever-green revolution. The country has invaluable assets—enormous diversity of bioresources and production environment, high precipitation, long coast line, large marine potential, vast natural resource base for agriculture and industrial growth, and rich traditional knowledge. Moreover, its vast renewable energy source (solar, wind, biomass and biogas), large pool of trained personnel, vast irrigation network, emerging private sector, and the rapidly growing domestic market are vital ingredients for improving productivity, quality, value addition, diversification and trade. With major advances in space, nuclear energy, information and communication, medical, biotechnology, management and other sciences, the country is now in a position to translate its physical and biological resources into economic wealth and prosperity.

Vision

By 2020, India will be free of poverty, hunger and malnutrition, and become an environmentally safe country. This, we believe, will be possible to achieve through accelerated social and economic development — by harnessing the advances in science, and blending them with our indigenous knowledge, wisdom and unique sociocultural ethos. We believe India can banish poverty and emerge as a developed nation by promoting growth through efficient and sustainable use of our human, natural and other resources.

Strategy

Since 1920, more than 120 international declarations, conventions and resolutions have focussed on population, food, nutrition, and environmental issues. These have led to a global consensus and commitment. India is a signatory and a strong advocate of fulfilling these commitments. It is imperative that we tap complementaries and harness synergies through global partnerships in science and technology. India will continue to support the use of science and technology, to achieve equitable growth of all nations and narrow the current divide between the rich and the poor.

While food, nutrition and environmental security are directly linked to agriculture, other related sectors — industry, health, education, space, etc. — will play an important role in achieving sustainable food self-sufficiency. We are convinced that sector-based prescriptions will not be adequate to meet the demands of emerging complex challenges. The strategy must therefore focus on intersectoral, inter-disciplinary and inter-institutional interactions.

The strategy accords priority to synergy among science and technology, organisation and public policy in order to improve the productivity of major farming systems through sustainable intensification, diversification and value addition. Substituting knowledge for capital should be the unique mission of Indian science. We also need to eliminate technology dissemination losses through total reorganization of technology transfer systems, making it client controlled and driven. The future will undoubtedly witness revolutionary changes and new horizons opened up by cutting-edge science. We need to coalesce the efforts of the entire scientific community and commit ourselves to fulfilling the vision in a socially relevant and participatory mode. Raising our capability and excellence in science is the most effective and relevant long-term strategy for overall national progress. The National Agricultural Policy emphasizes the strategic role for science and technology to ensure growth with food, nutrition and environmental security.

Commitment

It is our consensus view that a vibrant, responsive and globally competitive science system is crucial to attaining sustainable food, nutrition and environmental security. This calls for strong social support and commitment to science. The following will require specific attention:

- Orient publicly supported science towards poverty, employment, livelihood, environment and other public good related issues on a priority basis.

- Make concerted efforts in all related areas of science and humanities, drawing strength from new frontiers as well as from our vast pool of traditional knowledge and wisdom.
- Evolve and implement an integrated science plan which is multi-faceted, multi-disciplinary and inter-institutional, focusing as much on population, education, gender, poverty, employment, nutrition and environment, as on production, sustainable growth and trade.
- Double public and private investments in research in the next five years. Ensure that private investments in proprietary science and technology do not hurt science and society.
- Focus scientific efforts on eco-regional and farming system basis to develop efficient technologies for enhanced productivity, post-harvest management, diversification and value addition, and rural craft and industry to provide remunerative options to and raise employment of small-scale farmers, women and the landless in rural India.
- Initiate strong programmes on utilization of renewable energy sources, monsoon management, forest management, containment of chemicals and other pollutants, waste management, conservation and upgradation of physical resources and harnessing of bioresources for environmental sustainability.
- Form a consortium of scientific institutions at the regional or local level involving stakeholders and local organisations to make rural upliftment an interactive development process.
- Accelerate national, regional and international collaboration for technology generation, assessment and transfer through information and communication technologies, while safeguarding against the attendant risks of globalization in science and technology.
- Ensure that science for meeting basic human needs becomes the bottom line of our national science policies and strategies.

Affirmation

Hunger free India is an idea whose time has come. Let us launch a science-based crusade for elimination of hidden hunger and malnutrition by 2007 when the country will celebrate the 60 years of independence.

Press Information Bureau

News Feature

Government of India

INDIAN SCIENCE CONGRESS - 2001

T.V. Padma

Press Information Bureau

The curtains came down on this millennium's first Indian Science Congress on January 7, bringing to an end five days of deliberations on the most crucial problem facing India – how to feed its teeming billion plus people.

The focal theme of the congress, the 88th to be held in the country, was "Food, Nutrition and Environment Security", an issue of not just national but also contemporary global concern. It was all the more relevant keeping in view the country's target of a "Food Secure India by 2015" and the Government's announcement to double food production in this decade. In keeping with the theme, the congress was held in the sprawling campus of India's premier Indian Agricultural Research Institute in New Delhi, where the seeds of India's Green revolution were first sown.

The congress opened on January 3 with the traditional ceremonial address by Prime Minister Atal Bihari Vajpayee and attended by Minister for Science and Technology Murli Manohar Joshi, Minister for Agriculture Nitish Kumar, Chief Minister of Delhi Shiela Dixit. The pace of the congress was set by the Prime Minister who asked scientists to come up with comprehensive and useful recommendations to deal effectively with food, nutrition and environment security. In his inaugural address Vajpayee reminded scientists that the three factors simultaneously impacted several critical areas of India's development. India today is not facing a shortage of food, but of facilities to store food, he pointed out. Having achieved food sufficiency, the country's aim is to achieve food security for all its citizens and overcome malnutrition.

The new century will be the century of knowledge and India cannot afford to have under-nourished children with poor brain development. Nearly one-third of Indian children are undernourished, more than half of the pregnant women and children are anaemic, and protein and vitamin deficiencies are rampant, Vajpayee

warned. "These realities overshadow our achievements and burden our national conscience".

The task of ensuring food, nutrition and environment security in a vast country like India is gigantic. What is needed is a collective and coordinated action among scientists, and those associated with agriculture and food economy. Accomplishing this task requires massive efforts in many areas that range from increasing crop yields to improving rural infrastructure, preventing huge wastage and losses that now characterise Indian food economy, Vajpayee said.

From the Government's side, the Prime Minister reiterated his pledge to hike investments in research and development to 2 per cent of the Gross Domestic Product (GDP) over the next five years. He said the government was considering setting up a National Mission for Technology Education and announced that Centre would initiate steps to restructure the Food Corporation of India to reduce costs and introduce more efficiency in procurement, storage and distribution of foodgrains.

The Prime Minister also urged scientists to take bold and unconventional initiatives and seize opportunities arising on the horizon. One is the information generated by the Human Genome Project and the country's rich biodiversity. India already has a superb information technology (IT) manpower as well as people trained in biosciences. India should be in the vanguard of the new wave of bioinformatics and create new "Genome Valleys" on the lines of the Silicon Valleys, he said.

Earlier in his presidential address, the General President of the Science Congress, Dr R S Paroda, who also heads the Indian Council of Agricultural Research (ICAR), reminded the gathering about India's long march towards attaining food sufficiency. India has since then achieved Blue, White and Yellow Revolutions and is on its way to a new "rainbow revolution" in nutrition.

But, Paroda pointed out, the great Indian paradox continues. On one hand, the country has had a record harvest of 206 million tonnes, is the second largest producer of milk with 76 million tonnes, and the second largest producer of rice, wheat, fruits and vegetables in the world. On the other hand, the country also has the world's largest number of poor people of about 250 million, who do not get two square meals a day.

Paroda outlined what he described as the "Panch Sutra" strategy consisting of five Ps to realize India's vision of being rid of poverty, hunger and malnutrition and become environmentally safe by 2020. These are: People, Productivity, Permanency, Policy and Partnership.

A Vision statement released during the inauguration pledged that "By 2020, India will be free of poverty, hunger and malnutrition and become environmentally safe. This, we believe, will be possible to achieve through accelerated social and economic

development – by harnessing the advances in science, and blending them with our indigenous knowledge, wisdom and unique socio-cultural ethos. We believe India can banish poverty and emerge as a developed nation by promoting growth through efficient and sustainable use of our human, natural and other resources."

The statement called for a science-based crusade for elimination of hidden hunger and malnutrition by 2007 when the country will celebrate 60 years of Independence.

Principal Scientific Advisor to the Government, Dr A P J Abdul Kalam, in a special lecture said India should aim at a Gross Domestic Product (GDP) growth of 9-11 per cent annually and reduce the people below the poverty line to negligible levels. The country should work for a 4th or 5th position in terms of GDP and world competiteveness by 2020, he said.

Kalam also stressed the need to network five areas – agriculture and food processing; electric power; education and health care; information technology; and strategic sectors such as nuclear, space and defence technologies – for economic strength and national security.

The crop and food focus of the congress continued in the plenary sessions, public fora discussions and sectional addresses thereafter. But what made this congress unique was the participation of farmers from different parts of India, as well as students who joined the scientists. Addresses by three innovative farmers specially invited to talk at the congress – D P Yadav from Bihar, Raju Yadav from Andhra Pradesh and Krishna Vir Choudhary from Delhi – added to the predominantly agricultural flavour of this science congress.

The congress attracted several international experts including Dr Peter Raven from Missouri Botanic Garden in the USA, Dr Franklin Zweig from Einstein Institute of Science, Health and The Courts in Chevy Chase in USA, Anand M Chakravorty from USA who received the first patent on an artificially created life form – a microbe – and Gurdev Khush from International Rice Research Institute (IRRI) in the Philippines, and Dr S K Vassal from Centre for Improvement in Maize Yield (CIMMYT) in Mexico. Other international experts included J M Lenne from International Crops Research Institute and C D Thatte from International Commission on Irrigation and Drainage, Dr S Shantaram from International Food Policy Research Institute (IFPRI) in Washington and Prof Krishna R Dronamraju from Foundation for Genetci Research in Texas

A highlight of the congress was Dr Swaminathan's advise to the Government to issue a White Paper on Indian agriculture in context of the World Trade Organisation (WTO). Such a White Paper would help dispel misgivings and reassure 70 per cent of India's population that their livelihood options are not being mortgaged without adequate consultations and consensus. Dr Swaminathan

also suggested a National Federation of Agricultural Organisations to give voice to their views on macroeconomic policies which are so far only oriented towards big business houses.

The five days of deliberations led to several key recommendations on research and policy issues. On the research front, scientists agreed on the need to unshackle research and educational institutions from bureaucratic control, new initiatives to set up genomic valleys and enhance investment in agricultural R and D to at least 2 per cent of agricultural GDP to achieve the targeted growth of 4 per cent in agriculture. Other key recommendations included integration of frontier technologies such as space (where satellites aid in a range of activities ranging from estimating crop acreage to fishing zones), atomic energy (where irradiation can create high yielding crop mutants) and biotechnology.

Scientists also called for a "rainbow" revolution" by 2020 that will make India free of poverty, hunger and malnutrition.

On the policy front, scientists recommended new initiatives to cope with WTO, especially by improving efficiency of domestic production, processing and marketing; and creating a "livelihood box" while renegotiating to allow developing countries to impose quantitative restrictions on import of agricultural commodities if they are likely to damage livelihood opportunities. Other major suggestions included networking multiple technologies for nation building, precision farming, transforming scientific institutes into "new age" institutions, and revamping agricultural extension system.

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List of Symposia/Workshops/ Brainstorming Sessions Organized

Sr. No.	Event	Title	Date(s)
1.	Brainstorming Session	Enabling Regulatory Mechanisms for Release of Transgenic Crops	October 18, 2003
2.	Brainstorming Session	Role of Science and Society towards Plant Genetic Resources Management - Emerging Issues	January 7-8, 2005
3.	National Workshop	Role of Information Communication Technology in Taking Scientific Knowledge/Technologies to the End Users	January 10-11, 2005
4.	Brainstorming Session	Farmer-Led Innovations for Increased Productivity, Value Addition and Income Generation	October 17, 2005
5.	National Workshop	Farmer-Led Innovations Towards Plant Variety Improvement, Conservation and Protecting Farmers' Rights	November 12-13, 2006
6.	Brainstorming Session	Models of Public-Private Partnership in Agricultural Biotechnology	April 7, 2007
7.	Symposium	Farmer-Led Innovations for Sustainable Agriculture	December 14-15, 2007
8.	National Symposium	Quality Protein Maize for Human Nutritional Security and Development of Poultry Sector in India	May 3, 2008
9.	Brainstorming Workshop	Emerging Challenges before Indian Agriculture - The Way Forward	March 6, 2009
10.	Brainstorming Workshop	Strategy for Conservation of Farm Animal Genetic Resources	April 10-12, 2009
11.	Brainstorming Workshop	Climate Change, Soil Quality and Food Security	August 11, 2009
12.	National Seminar	Quality Seed for Food Security through Public-Private Partnership	April 13-14, 2010

Sr. No.	Event	Title	Date(s)
13.	National Dialogue	Building Leadership in Agricultural Research Management	August 27-28, 2010
14.	Brainstorming Session	Prospects of Producing 100 million tons of Wheat by 2015	December 18, 2010
15.	Brainstorming Session	Stakeholders' Interface on GM Food Crops	May 19, 2011
16.	International Conference	Innovative Approaches for Agricultural Knowledge Management: Global Extension Experiences	November 9-12, 2011
17	National Workshop	Farmers' Led-Innovation	December 23-24, 2011
18.	Global Conference	Women in Agriculture	March 13-15, 2012
19	Workshop	Foresight and Future Pathways of Agricultural Research through Youth	March 1-2, 2013
20.	Brainstorming Workshop	Achieving Inclusive Growth by linking Farmers to Markets	June 24, 2013
21.	National Workshop	Out-scaling Farm Innovation	September 3-5, 2013
22.	Brainstorming Workshop	Strategies for Conservation and Productivity Enhancement of Farm Animal Genetic Resources	January 10, 2014
23.	Brainstorming Workshop	Soybean for Household Food and Nutrition Security	March 21-22, 2014
24.	Brainstorming Workshop	Up-scaling Quality Protein Maize (QPM) for Nutrition Security	May 20-21, 2015
Other events scheduled to be organized in 2015			
25.	National Dialogue	Efficient Nutrient Management for Improving Soil Health	September 28-29, 2015
26.	Regional Consultation	Agroforestry: The Way Forward	October 8-10, 2015
27.	National Dialogue	Innovation Extension Systems for Farmers' Empowerment	November 4-6, 2015

Foundation Day and Special Lectures Organized

Lecture	Title	Speaker	Date
First Foundation Day Lecture	Regulatory Measures for Utilizing Biotechnological Developments in Different Countries	Dr. Manju Sharma, Secretary, Department of Biotechnology, Government of India	October 17, 2003
Special Lecture	Challenges in Developing Nutritionally Enhanced Stress Tolerant Germplasm	Dr. S.K. Vasal, Distinguished Scientist, International Center for Improvement of Maize and Wheat	May 3, 2004
Second Foundation Day Lecture	Public-Private Partnership in Agricultural Biotechnology	Dr. Gurdev S. Khush, Adjunct Professor, University of California, Davis, USA	October 17, 2005
Third Foundation Day Lecture	Global Efforts for Improving Quality Protein Maize (QPM)	Dr. S.K. Vasal, Distinguished Scientist, CIMMYT, Mexico	May 3, 2008
Fourth Foundation Day Lecture	Overcoming the World Food and Agriculture Crisis through Policy Change, Institutional Innovation and Science	Dr. Joachim von Braun, Director General, IFPRI, Washington	March 6, 2009
Fifth Foundation Day Lecture	Climate Change and Food Security: From Science to Sustainable Agriculture	Dr. Mahendra M. Shah, Director, Qatar National Food Security Program	May 7, 2010
Special Lecture	Global Perspective of Wheat Improvement	Dr. Sanjay Rajaram, former Director, Wheat Program, CIMMYT	December 18, 2010
Sixth Foundation Day Lecture	Harnessing Knowledge for India's Agricultural Development	Dr. Uma Lele, Former Senior Advisor, FAO	August 12, 2011

Lecture	Title	Speaker	Date
Special Lecture	Challenges and Opportunities for Food Legume Research and Development	Dr. M.C. Saxena, Eminent Agronomist and Crop Physiologist, ICARDA	January 25, 2012
Seventh Foundation Day Lecture	Ensuring Food and Nutrition Security in Asia: The Role of Agricultural Innovation	Dr. Shenggen Fan, Director General, IFPRI	January 11, 2013
Special Lecture	Enhancing Smallholder Farmer Participation in Markets: The IMOD Way	Dr. William D. Dar, Director General, ICRISAT, Hyderabad	June 24, 2013
Eighth Foundation Day Lecture	Sustainable Agricultural Development – IFAD's Experiences	Kanayo F. Nwanze, President, IFAD	August 5, 2014

Recipients of Dr. M.S. Swaminathan Award for Leadership in Agriculture and their Citations

Sr. No.	Award	Recipient	Presented by	Date
1.	First Dr. M.S. S. Award for Leadership in Agriculture	Dr. Norman E. Borlaug	Dr. A.P.J. Abdul Kalam, Hon'ble Former President of India	March 15, 2005
2.	Second Dr. M.S. S. Award for Leadership in Agriculture	Dr. Gurdev S. Khush	Dr. Manmohan Singh, Hon'ble Former Prime Minister of India	October 9, 2006
3.	Third Dr. M.S. S. Award for Leadership in Agriculture	Dr. S.K. Vasal	Prof. M.G.K. Menon, Former Member, Planning Commission	May 3, 2008
4.	Fourth Dr. M.S. S. Award for Leadership in Agriculture	Prof. Rattan Lal	Dr. Montek Singh Alhuwalia, Former Deputy Chairman, Planning Commission	August 11, 2009
5.	Fifth Dr. M.S. S. Award for Leadership in Agriculture	Dr. Sanjay Rajaram	Dr. A.P.J. Abdul Kalam, Hon'ble Former President of India	December 18, 2010
6.	Sixth Dr. M.S. S. Award for Leadership in Agriculture	Dr. M.C. Saxena	Dr. Balram Jakhar, Former Union Minister of Agriculture & H.E. Governer of Madhya Pradesh	January 25, 2012
7.	Seventh Dr. M.S. S. Award for Leadership in Agriculture	Dr. William D. Dar	Dr. K. Kasturirangan, Former Member, Planning Commission	June 24, 2013
8.	Eighth Dr. M.S. S. Award for Leadership in Agriculture	(To be presented) Dr. Thomas Lumpkin	Padma Vibhushan Dr. M.S. Swaminathan, World Food Laureate	September 28, 2015

Citation

Dr. Norman E. Borlaug

Dr. Norman E. Borlaug, an epitome of agricultural research and development, dedicated to the alleviation of world hunger and poverty, was born in Cresco, lowa on March 25, 1914. He received B.S. Degree in forestry and the M.S. and Ph.D. in plant pathology from the University of Minnesota, USA.

In 1944, he was appointed geneticist and plant pathologist assigned to organize and direct a Cooperative Wheat Research and Production Programme in Mexico. Due to his dedicated efforts, the programme became an outstanding success. It eventually made Mexico self-sufficient in wheat production by 1956 and laid the foundation for wheat improvement and increased production in other parts of the world.

In 1963, Dr. Borlaug became the leader of the Wheat Programme of newly established International Maize and Wheat Improvement Centre (CIMMYT). In this position, he directed his efforts to wheat research and production problems in Asia. The high yielding, fertilizer-responsive, disease resistant and widely adapted dwarf wheat varieties developed by him laid the foundation for the 'Green Revolution' in various parts of the world, especially in India. He has been visiting India regularly since 1963 and has been a source of great inspiration to all Indian agricultural scientists and scholars.

Dr. Borlaug, Fellow of Science Academies of 15 countries, including the Indian National Science Academy and National Academy of Agricultural Sciences, India, has been conferred honorary doctorate degree by 51 Universities from all over the world. He is a recipient of numerous academic, scientific and civic awards. He is the only agricultural scientist in the world who received Nobel Peace Prize in 1970.

Dr. Borlaug currently denotes his time as a Senior Consultant to CIMMYT, as a Distinguished Professor of International Agriculture, Department of Soil and Crop Science, at Texas A&M University and as President of Sasakawa Africa Association. He also serves as ex-officio consultant on wheat research and production problems to many governments in Latin America, Africa, and Asia. Since 1980, he has been working hard to bring about a Green Revolution in Africa.

In appreciation of his monumental contributions to Indian agriculture and for being a great motivating force to propel agricultural research for world food security, the Trust for Advancement of Agricultural Sciences, New Delhi, India has great pleasure in honouring Dr. Norman E. Borlaug with the 'First Dr. M.S. Swaminathan Award for Leadership in Agriculture' on this Fifteenth day of March, 2005.

Citation

Dr. Gurdev Khush

Dr. Gurdev Singh Khush, a world renowned plant breeder, has made enormous contributions to the development of more than 300 high yielding rice varieties that played significant role towards achieving 'Green Revolution'. A worthy son of a farmer, Dr. Khush graduated from the Punjab Agricultural University, Ludhiana in 1955. He joined the International Rice Research Institute (IRRI), Manila in 1967. In 1986, he was promoted as Principal Plant Breeder and Head, Division of Plant Breeding, Genetics and Biochemistry. He provided excellent leadership for the global rice improvement program benefiting millions of resource poor rice growers in the world. A semi-dwarf rice variety IR36, developed by him was one of the most widely grown rice varieties in the world during 1980s. IR64 developed during 1980s is the most widely planted rice variety in the world.

Dr. Khush is one of the most decorated agricultural scientists in the world. He received honorary Doctorate degrees from nine universities, including University of Cambridge, England. He is one of the five Indian scientists who have been elected to the membership of the Royal Society as well as US National Academy of Sciences. For his monumental contributions to rice improvement, he received Japan Prize (1987), the World Food Prize (1996), the Wolf Prize from Israel (2000) and the China International Scientific and Technological Cooperation Award (2001). He was honoured by the Government of India with the prestigious "Padma Shri" Award in 2000.

In India, Dr. Khush has been actively involved in the development of plant breeding and agricultural biotechnology. He has been a member of the Scientific Advisory Committee (Overseas), of the Department of Biotechnology, Government of India, for over a decade. He worked closely with the Indian Council of Agricultural Research (ICAR) for enhancing human resource development for improving rice productivity in India. He retired from IRRI in 2002 and joined the University of California, Davis, as Adjunct Professor.

The Trust for Advancement of Agricultural Sciences salutes this great son of India and take pride in honouring Dr. Khush with the prestigious Dr. M.S. Swaminathan Award for Leadership in Agriculture' on this Ninth day of October, 2006.

Citation

Dr. Surinder K. Vasal

Dr. Surinder K. Vasal is an accomplished plant breeder and geneticist whose work on maize led to the development of high quality protein maize (QPM). He, along with his colleague, Dr. Evangelina Villegas shared the 2000 World Food Prize for their valuable contributions.

Dr. Vasal was born in 1938 in Amritsar, India. He did Ph.D. in Genetics and Plant Breeding from the Indian Agricultural Research Institute, New Delhi. Dr. Vasal began his career as a researcher in the Department of Agriculture, Himachal Pradesh and later worked as Maize Breeder at the Himachal Agriculture College.

In 1967, Dr. Vasal took up an assignment with the Rockefeller Foundation in Thailand to conduct research on maize in close collaboration with the National Corn and Sorghum Research Center of Kasetsart University. From there, he moved to the International Maize and Wheat Improvement Center (CIMMYT), Mexico in 1970 and supervised the high lysine maize program. He also held positions of Germplasm Coordinator, Head of Maize Research and Coordinator of Asian Regional Maize Programme. Dr. Vasal was honoured to be the first distinguished scientist at CIMMYT.

With the development of quality protein maize, the amino acid content in the diets of several millions has improved since 1990s. Quality protein maize germplasm, developed by Dr. Vasal is now being used worldwide for developing QPM cultivars. Dr. Vasal has developed important concepts and methodologies and released a large number of promising inbred lines for use by the maize researchers worldwide.

In 1997, Dr. Vasal took up a new role, leading CIMMYT's Asian Regional Maize Programme in Thailand. He strengthened regional hybrid research activities and coordinated the Tropical Asian Maize Network (TAMNET). He specifically played an important role in human resource development by training hundreds of young scientists from the developing countries.

Dr. Vasal is a member of the American Society of Agronomy, the Crop Science Society of America (whose Presidential Award he won in 2000), and India's National Academy of Agricultural Sciences. He has received the 1996 International Service in Crop Science Award and the 1999 International Agronomy Award, in addition to accolades from the Governments/Institutions in Honduras, Peru, Panama, India, Vietnam, Bangladesh and a few other countries. He is also the recipient of Chinese Friendship Award of 2001.

The Trust for Advancement of Agricultural Sciences takes pride in honouring Dr. Vasal with the Third Dr. M.S. Swaminathan Award for Leadership in Agriculture on this day, the 3rd May, 2008.

Citation

Prof. Rattan Lal

Professor Rattan Lal is an eminent soil scientist. His scientific contributions have made profound impact on sustainable management of natural resources and world food production among resource-poor farmers in the developing countries. He has conducted classical studies on watershed management and linked them to C-sequestration and climate change. He has liberally shared his research findings with other scientists, thus promoting effective soil management practices globally. His work has been recognized worldwide. Professor Rattan Lal has received numerous prestigious Awards including the 2007 Nobel Peace Prize Certificate and 2005 Norman Borlaug Award. He has held several important positions in a number of professional societies. He was elected President of the prestigious Soil Science Society of America in 2006-2007. Professor Rattan Lal has authored 1375 research papers, including 13 books, which have received great admiration of the scientific community and comprise principal reference materials in soil science.

Born on 5th September 1944 in Karyal, Punjab and educated at PAU and IARI. Professor Rattan Lal earned his Ph.D. from the Ohio State University in 1968. After working at IITA, Ibadan, Nigeria for 18 years, he joined OSU in 1987 as Professor of Soil Science. Since 2000, he holds the position of Director, Carbon Management and Sequestration Center, The Ohio State University, USA.

Professor Rattan Lal continues to do excellent work in Soil Science. His main areas of interest are: Soils and Climate Change, Carbon Sequestration in Soils, Sustainable Management of Soils in the Tropics, Global Food Security, Soil Degradation and Management, and making agriculture as a component of solutions to environmental issues.

The Trust for Advancement of Agricultural Sciences takes pride in honouring Professor Rattan Lal with the fourth Dr. M.S. Swaminathan Award for Leadership in Agriculture on this day, the 11th August, 2009.

Citation

Dr. Sanjay Rajaram

Dr. Sanjay Rajaram is one of the most distinguished wheat breeders known for his valuable contributions globally. He led CIMMYT's wheat breeding program for over two decades. Under his leadership, the CIMMYT program made tremendous impact on global wheat production.

As wheat breeder, Dr. Rajaram contributed towards the development of as many as 480 wheat varieties that have been released in 51 countries, and are grown on an estimated 58 million hectares worldwide. Twenty-five of his varieties have so far been released in India. For this contribution, he has been honoured with a number of national and international honours and awards.

Using a novel approach of exploiting winter and spring wheat gene pools, together with shuttle breeding and mega environment testing, Dr. Rajaram and his team developed outstanding cultivars with very high yield potential. Applying the concept of slow rusting, he developed wheat varieties with durable resistance to leaf rust, which invariably remained effective for more than 20 years. Dr Rajaram and his team also successfully incorporated blight resistance into modern wheat varieties.

Dr Rajaram graduated with a B.Sc. degree in Agriculture from the University of Gorakhpur. He obtained his Masters in Genetics and Plant Breeding from IARI, and proceeded to do his Ph.D. in Plant Breeding from the University of Sydney, Australia. Dr. Rajaram has authored/co-authored more than 400 research publications, including 110 papers in refereed journals, and mentored 700 young scientists from the developing world. He also guided 22 Masters and Ph.D. students. During his long career, he has served as Director of Wheat Research at CIMMYT, Director of ICARDA's Biodiversity and Integrated Gene Management Program, and consultant to a number of governments and international organizations. In 2009, he led a study in Egypt, the report of which is being used by the Egyptian Ministry of Agriculture to plan a major expansion of wheat production program.

The Trust for Advancement of Agricultural Sciences takes pride in honouring Dr. Sanjay Rajaram with the Fifth Dr. M.S. Swaminathan Award for Leadership in Agriculture on this day, Saturday, the 18th December, 2010.

Citation

Dr. M.C. Saxena

Dr Mohan C. Saxena is an eminent agronomist and crop physiologist, whose work at the International Center for Agricultural Research in the Dry Areas (ICARDA) on food legumes has enormously benefitted the resource poor farmers in West Asia, North Africa, Central Asia (CWANA) and South Asia, particularly Bangladesh, India, Nepal and Pakistan.

His work on managing drought, common in this region, resulted in the "Winter Sowing" technology for chickpea and lentils in the lowland Mediterranean areas of the West Asia and North Africa region, resulting in 50-60 per cent increase in crop productivity and water-use efficiency. This research was recognized through King Baudoin Award of the CGIAR for ICARDA and ICRISAT. He had served as leader of Legume Program, then as Director of Germplasm Improvement Program and also as Assistant Director General (ADG) at ICARDA for almost two decades. His support to Indian legume program, especially kabuli chickpea and lentil led to much greater benefits to resource poor farmers of India.

Dr Saxena did Ph.D. in Agronomy at the Indian Agricultural Research Institute (IARI), New Delhi (1962), and Doctor of Science in Plant Nutrition from the University of Hohenheim, Germany (1965). After serving briefly at IARI and the Bhaba Atomic Research Center, he joined the G. B. Pant University of Agriculture and Technology, Pantnagar and undertook research on agronomy of warm and cool season pulses, particularly soybean. His work on soybean greatly helped in popularizing Soybean Production Technology in India.

Dr Saxena's research contributions and leadership have been widely recognized. A major Laboratory at ICARDA is named after him for his accomplishments. He has been awarded Gold Medals by Indian Society of Agronomy and the Indian Society of Pulses Research and Development and Honorary Doctorates from three Universities. After his retirement from ICARDA, he has been appointed as a Visiting Professor at the Arid Land Research Center of the Tottori University, Japan. The Crop Science Society of America has recently given him a Lifetime Achievement Award by conferring an Honorary Membership of the Society.

In recognition of his important contributions, TAAS has great pleasure in awarding Dr. M.C. Saxena the Dr. M.S. Swaminathan Award for Leadership in Agriculture on this day, Wednesday, the 25th January, 2012.

Citation

Dr. William D. Dar

Dr. William D. Dar, Director General, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Hyderabad, Andhra Pradesh, has made outstanding contributions towards food security and agricultural sustainability in Asia and Sub-Saharan Africa. His work has created great impact on the lives of resource poor farmers. Dr. Dar has also actively promoted Public-Private-Farmer partnership linking strongly the end users with the National Agricultural Research System (NARS) as well as International Agricultural Research Centers (IARCs). Under his leadership, effective research collaboration has been established in areas like germplasm exchange, biotechnology, crop improvement, water conservation, capacity building, and policy reorientation.

Dr. Dar has had a distinguished career as an educator, agricultural scientist and able research administrator. Being a great promoter of regional cooperation, Dr. Dar also served as Chairman of the Asia-Pacific Association of Agricultural Research Institutions (APAARI).

Prior to joining ICRISAT, Dr. Dar had served as Advisor to the President of the Philippines; Secretary, Department of Agriculture of the Philippines; Executive Director of the Philippine Council of Agriculture, Forestry and Natural Resources Research and Development (PCARRD); Director, Bureau of Agricultural Research (BAR), Department of Agriculture; and the Vice President (R&D) of Benguet State University, Philippines.

In recognition of his significant contributions, Dr. Dar has been honoured with a number of awards and degrees of Doctorate of Science. He also received the Life-time Achievement Award for his outstanding contributions in the field of pulses research from the Indian Society of Pulses Research and Development (ISPRD).

Dr. Dar is a champion of the poor. He successfully led ICRISAT into renaissance and excellence with a motto of "Science with a Human Face". His transformational leadership has turned ICRISAT into a forward looking institute, financially strong and producing scientific breakthroughs as public goods for greater developmental impact. His passion is to help alleviate the socioeconomic conditions of the poor living in the semi-arid tropics of Asia and Sub-Saharan Africa.

In view of his outstanding contributions, the Trust for Advancement of Agricultural Sciences (TAAS) has great pleasure in awarding him the prestigious Dr. M.S. Swaminathan Award for Leadership in Agriculture on this day, Monday, the 24th June, 2013.

Building Trust:

The Journey of TAAS

2001-2015

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