4th International Agronomy Congress

Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge

November 22-26, 2016

Recommendations and Highlights

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Organizers

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ICAR
Indian Council of Agricultural Research
New Delhi, India

Indian Society of Agronomy
ICAR-IARI, New Delhi, India

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Fourth International Agronomy Congress

on

Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge

November 22-26, 2016, New Delhi, India

Recommendations

and

Highlights

Indian Society of Agronomy
Division of Agronomy
Indian Council of Agricultural Research
Indian Agricultural Research Institute
New Delhi 110 012

Recommendations and Highlights of Fourth International *Congress on "Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge"* November 22-26, 2016, New Delhi, India

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4th International Agronomy Congress: Major Recommendations

Delhi Declaration: 'Agronomy for Evergreen Revolution'

The Indian Society of Agronomy in collaboration with Indian Council of Agricultural Research organized the 4th International Agronomy Congress on "*Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge*" at New Delhi during 22-26 November, 2016. This Congress was inaugurated by Prof. M.S. Swaminathan, World Food Laureate. The Congress took note of the fact that today's agriculture is challenged by climate change, land degradation, loss of biodiversity, food and energy crisis, and population explosion. To liberate the developing world, especially south Asia and Africa, from twin scourge of hunger and poverty, we need strategies for and greater investments on Natural Resource Management (NRM) innovation-led accelerated and sustainable agricultural growth, with emphasis on resource-poor smallholder farmers. It was recognized that the task of achieving zero hunger was daunting but not insurmountable, and Agronomy can and has to play a major role in realizing this goal. Agronomic research, facilitated by good quality science and tackling practical problems of the farmers individually and collectively, is essential to enhance productivity and raise farmers' income. The strategies for sustainable natural resource management include scientific landuse planning, conservation agriculture, precision agriculture (water and nutrient management) contract farming, organic farming, farming systems approach, climate smart agriculture, and strengthening collaboration and partnerships for up-scaling the technologies.

All these issues were covered in the deliberations under the detailed agenda of the Congress that comprised 4 evening lectures, 8 plenary presentations, 4 special sessions, a panel discussion, and 12 symposia with 18 keynote addresses, 78 lead and 67 rapid fire presentations. In the inaugural session, 3 text books, viz. Climate Resilient Agronomy, Modern Concepts of Agronomy, and Weed Science and Management were released. Besides these, special issues of Indian Journal of Agronomy, Indian Journal of Fertilisers, Indian Farming and *Kheti* were also brought out. The Congress was attended by more than 1,000 participants from 22 countries.

The major recommendations that emerged out of these deliberations, having implications for research, development and policy, are presented below as "Delhi Declaration: Agronomy for Evergreen Revolution".

1. It was recognized that Agronomy has served the world community in the past by ensuring adequate food and nutritional security. However, in view of the emerging problems, there is a need for reorienting our strategies to achieve the zero hunger challenge. This requires a paradigm shift in our research and development agenda as well as policy support.
2. For making agronomic innovations relevant to the present needs of farmers, systems research is essential, and the cropping system modelling would extend and enhance traditional agronomic research. To understand the likely ef-

fects of future climate on the current and alternative management practices, cropping system models, such as Agricultural Production Systems Simulator (APSIM), would enable to compare alternative cropping systems and quantify their value across different metrics.

3. Green Revolution of 1960s was based on seed-based technology with proper agronomic management. However, looking into the level of natural resource degradation, food and nutritional insecurity, the evergreen revolution must be based on farming systems commodities. Meeting the goal of sustainable food security would necessitate development of alternative cropping based on the natural endowments of different regions and needs of the local communities. Integrated farming system comprising crops, horticulture, livestock, fisheries, and other secondary activities has great potential for increasing farm income by 3-4 times in irrigated regions. Farming systems are highly location-, house hold-, resource- and management-specific. Appropriate statistical methodology, tools and sustainable farming system indicators need to be developed. Technical support, access to credit and markets and risk management are essential for promotion of integrated farming. There are several success stories in this regard, which must be replicated for wider impacts.
4. Agricultural diversification and value addition can substantially increase farm incomes. There should be development of value chains and linkages of farmers with markets. This shall require more investment, access to post-harvest technology and quality raw material. Enhancing productivity, risk management and promotion of value chains shall also require addressing the issues of last mile delivery of services through horizontal and vertical linkages with different institutions. Diversification should be technology- and market-driven. Digital technologies and modeling will be valuable tools in these efforts. Value tagging to ecosystem services will have to be taken into account in the overall assessment of system productivity and economics.
5. Agriculture is contributing to GHG emissions, which have great implication for climate change impacts. The projected impacts of climate change on agriculture pose a serious threat for future food security. Climate smart agriculture can be a key to sustainable agriculture, provide resilience to farmers and reduce GHG emissions. Agronomic practices, such as conservation agriculture focusing on reduced tillage, legume-based diversified cropping system, and recycling of crop residues that lead to reduction in carbon footprint and increase carbon sequestration *in-situ* should therefore be promoted. Towards mitigation strategy for climate change, the technology of direct-seeded rice holds promise in saving of scarce water resources and reducing cost of production. Landscape modeling, regional weather forecasting and decision support systems would have to be promoted. Climate resilient technology modules and climate resilient village models have been developed by ICAR-NICRA, and a stage has come to bring them onto larger platforms. The revision and updating of the contingency plans should be given high priority.
6. Conservation agriculture (CA) systems need to be promoted in all major production systems, particularly rainfed and hill ecologies where soil loss is pre-

dominant, with strong research-based strategic planning. It should be integrated as a core component of national agricultural development plans for sustainable intensification in all major cropping systems. Since CA is herbicide-based practice, management of weed seedbank needs more emphasis over other weed control practices. Conservation agriculture have produced several success stories but adoption by farmers is slow. Site-specific refinement is needed, which should be done with the involvement of farmers. A multi-stakeholder CA platform should be established at national and regional level (like Rice-Wheat Consortium) to serve as knowledge repository, monitoring and evaluation centre, and policy think-tank.

7. Integrated in-season drought management system, with components of agro-advisories, drought-tolerant cultivars, efficient rainwater management and strategic use of water with efficient delivery system, is essential for enhancing the resilience of rainfed / dryland farmers.
8. Agronomists and plant breeders should work together to develop new plant types and assess stable yielding genotypes containing climate smart traits. Natural resource management requires technologies for appropriate soil management, integrated water management and farming systems for these identified promising genotypes to perform in diverse environments.
9. Satellite imagery, if available at low cost, can leapfrog the application of precision nutrient management strategies in smallholder systems. Concerted efforts are needed to integrate near real time imagery to nutrient management approaches to provide in-season flexibility to achieve productivity and profitability under climate change scenario.
10. Awareness about water-saving technologies with the aim of getting ‘more crop per drop’ will have to be promoted. Use of wastewater in a safe manner for crops such as medicinal plants, shrubs and timbers, either straight or in conjunctive use with blue water, will be a promising way of sustainable agricultural production. Techniques for the use of modern irrigation systems, including sub-surface and deep drip irrigation system, will have to be perfected. Low-cost waste water treatment technology, which is energy efficient, should be further evaluated and popularized.
11. For hill ecosystem, effective conservation (for soil, water and biodiversity) technologies focusing on integrated farming system through participatory and convergence approach need to be promoted for food and nutritional security and livelihood improvement for small and marginal farmers. To promote organic farming in hill ecosystem, emphasis should be given for assessing effective microbial consortia for efficient biomass recycling for sustaining soil health.
12. Adoption level of reclamation process of problem soils (sodic, saline, acid i.e.) is slow due to non-availability and costly amendments. Location-specific problem-based innovative technologies, such as land configuration, stress-tolerant genotypes, furrow liming with reduced dose, seed pelleting/coating, and use of nano particles need to be introduced for exploring sustainability and better adoption.

13. Coastal ecosystem is vulnerable to climate change and needs to be protected. Therefore, to conserve coastal ecosystem and improvement of livelihood of coastal farmers, integrated farming system with special emphasis on agroforestry and fish farming needs immediate attention.
14. Evidence-based agronomy and meta-data sharing and analysis is a new area for collaboration and development of necessary expertise to meet the zero hunger challenge. There is a need to share and publish quality data sets, and train young scientists and students in data stewardship, systematic reviews and meta-analysis.
15. Efficient scaling of delivery of new technologies to the farmers is essential for achieving the desired impact. Innovation-led, business-allied, service-centric, foresight-based, multi-linear technology delivery and adoption models should replace or complement the existing public sector led extension systems. However, it would require skill development and confidence building among stakeholders to achieve the last mile delivery.
16. Besides food security, nutritional security is an essential element in the 'zero hunger' goal. Producing nutrient–rich crops (food and fruit crops) and vegetables would go a long way in the sustainable diversification and intensification of cropping systems. Promotion of cultivation of pulses and leguminous vegetables through creation of 'pulse villages' supported by 'Pulse *Panchayats'* would be an important step. Agronomists will also have to identify under-utilized crops rich in nutrients and niches in the cropping systems where they could be introduced. Additionally, use of protected agriculture, with hydroponics, aeroponics, vertical farming, etc. in the urban and peri-urban areas would help a great deal in providing nutritious food.
17. There are serious gaps in understanding the skill needs of agricultural sector. Therefore, a mission mode is needed to identify and prioritize skill needs, and institutionalize these in imparting knowledge to youth. Agriculture needs quality youth but current AR4D agenda is an incremental innovation and not attractive to the youth. Therefore, there is need for transformational innovation through trans-disciplinary and trans-stakeholder approach at different levels, i.e. redesigning agricultural education system for entrepreneurship, and not just for research and extension. Vocational training, inclusion of agronomic education in school curriculum especially on climate smart, organic farming and farming system-based farmers' participatory approach for technology generation, transfer and adoption are needed to ensure faster growth in agriculture.
18. In order to promote development of farmers-led skills as well as protect their rights, it is necessary to recognize and further promote these innovations. It is also desirable to blend the farmers' innovations with the modern scientific knowledge and properly upscale them for the benefit of farming community.
19. Farmers income can be doubled by adoption of integrated approach, involving new aboitic and biotic stress tolerant genotypes, low-cost efficient water harvesting technology, timely inputs and credit support, nutrient scheduling on the basis of soil health card, and smart mechanization of agricultural prac-

tices. Therefore, large scale demonstration on integrated approach involving farmers is must to achieve his target.

20. A continuing committee was constituted with Dr Paul E. Fixen, Dr John Dixon, Dr Matthew Morell, Dr David Bergvinson, Dr R.S. Paroda, Dr Amir Kassam, Dr M.C. Saxena, Dr Javed Rizvi, Dr R.B. Singh, Dr M.L. Jat and Dr Gurbachan Singh for holding the dialogue for the next International Agronomy Congress in a country other than India to make it a global event. The committee should approach Presidents of well established societies of Agronomy, such as American Society of Agronomy, European Society of Agronomy, Canadian Society of Agronomy, Chinese Society of Agronomy, Brazilian Society of Agronomy, and others with the aim of working together and finalizing the venue of the 5th International Agronomy Congress to be held in 2020.

For realizing the above goals, we the Agronomists of India and elsewhere hereby adopt the Delhi Declaration and resolve to work together with all stakeholders for sustainable management of natural resources, environment, energy and livelihood security to achieve zero hunger challenge.

4th International Agronomy Congress: Highlights of Sessions

Twentieth century witnessed an outstanding and unprecedented scientific and technological development in all fields ranging from agriculture to industry and further to information technology. This progress has virtually transformed human life in terms of prosperity and higher standards of living for a section of global population. Yet, the paradox before us is the stark reality that large segment of humanity is still trapped in hunger and poverty. In view of this, recently UNO has declared world transforming with its agenda of Sustainable Developmental Goals (SDGs) for 2030. The first and second goals are to end poverty in all its forms everywhere, and to end hunger, achieve food security and improved nutrition and promote sustainable agriculture.

In the changing climate scenario, there is a need to change our research priorities especially under rainfed agriculture for judicious use of available rainfall and amelioration of stresses due to biotic and abiotic factors. Further, there is also a need for crop diversification, which itself includes varietal diversification, technological innovations and flexible calendar to match weather and climate change. Declining soil organic carbon status along with deficiency of micronutrients is another threat to sustain the growth rate of productivity. Conservation agriculture has potential for managing the declining soil productivity besides combating the climate change.

Another important area of research is the resource conservation techniques which require strengthening for improving the resource-use efficiency and improving the natural resource base. The per capita water availability has come down from 3100 m^3 in 1975 to 1900 m^3 in 2000, and it is likely to decline further to 1400 m^3 by 2025. This calls for special attention of the agronomists to manage this precious resource by developing techniques for its efficient use. The precision irrigation technologies developed so far need further refinement and upgradation. An integrated farming system, irrespective of combination of crops, and enterprises, location, management and socio-economic conditions has resulted in higher profit in all the case studies carried out so far. This approach has the potential to take care of livelihood, environment and energy security through multiple and efficient use of

resources. Due to environmental and economic constraints, further increase in productivity and production will be possible through resource-use efficiency and multiple use of limited resources. There is also a need to develop integrated soil-crop system management, which is capable of increasing the crop yield as well as sustainable use of natural resources. Crop demand–driven and site-specific nutrient application techniques can add to farmer's profit and reduce pollution.

Under these circumstances, the science of 'Agronomy' which confines the knowledge and findings of other disciplines of agriculture and basic sciences and translates them into innovative technologies for the use of farmers, has to play an important role. The Indian Society of Agronomy has a unique history of organizing three successful International and 20 National conventions, which helped in achieving the food and nutritional security. Fourth International Agronomy Congress was organized to review the progress and work out strategies to meet the challenges of food, nutrition, environment and livelihood security to achieve zero hunger challenge by generating new opportunities through agronomic research, and provide an international platform to discuss the emerging issues for preparing a road map.

INAUGURAL SESSION

The 4th International Agronomy Congress organised by the Indian Society of Agronomy (ISA) was inaugurated on 22nd November, 2016 in which over 1000 delegates from over 22 countries of the world participated. The inaugural session was presided over by Dr. Gurbachan Singh, Chairman, ASRB, ICAR and President, Indian Society of Agronomy; and graced by the august presence of Prof. M.S. Swaminathan as Chief Guest; and Dr. T. Mohapatra, Secretary, DARE & DG, ICAR; Dr. R.S. Paroda, former Secretary, DARE & DG, ICAR; Dr. John Dixon, Principal Advisor, ACIAR, Canberra, Australia; Dr. Paul E. Fixen, President, American Society of Agronomy as Guests of Honour; and Dr. Ravinder Kaur, Director, IARI, New Delhi.

While welcoming the delegates, Dr. Gurbachan Singh briefed the gathering about the theme of the Congress and expected output to prepare a road map for evergreen revolution. He stressed upon: (i) upgradation of Congress as a global event with the involvement of other international organizations/societies interested in promotion of agronomy; (ii) based upon discussions to prepare a Delhi Declaration targetting the theme 'Agronomy for Evergreen Revolution', and (iii) shift from individual crop/commodity/enterprise oriented research to multi-enterprise agriculture for multiple use of resources to remove poverty and hunger. The disenchantment with agriculture as a profession by the youth is one of the major problem that developing economies face today.

Dr. Ravinder Kaur expressed the need of stemming the degradation of arable lands of about 2 billion ha across the globe and rethinking about conversion of fertile tracts to non-agricultural use. The accelerating trend of natural resource erosion and unforeseen cumulative irreversible harm need to be duly addressed. She stressed upon the synchronous and harmonious management of agriculture and supporting biosphere.

Dr. T. Mohapatra urged to define the sustainability parameters and work out sustainability indices which will ease the way to calibrate different farming systems and to customize them for different situations. He reminded about the recognition of oneness of the nature, and to face the challenge of bringing zero hunger, world experts must have holistic approach of research. He urged to bring out a declaration in the form of recommendations for the agriculturists of the world. Dr. Mohapatra emphasized on agronomy of new plant types and perennial crops including horticulture and agroforesty particularly under rainfed conditions. He desired that effective solutions for rice residue burning in Punjab and Haryana through conservation technologies should be developed. He also advocated refinement and standardization of agricultural technologies recommended by the scientists through multi-locational testing and verification. Further, he stressed on the following points:

- Green revolution in India during 1960s was achieved not only because of good quality seeds but also because of the improved package of agronomic practices.

- For achieving potential productivity of new plant types, a paradigm shift in agronomic management is needed.
- Agronomy of horticultural and other perennial crops has not been given due emphasis in the past. This needs to be worked out on a long-term basis.

- Sustainability indices for various crops / cropping systems and associated agronomic technologies are to be established in the context of climate change.
- Rainfed agronomy requires a total reorientation.
- There is a need to find out effective and potential solutions to the problem of stubble burning through agronomic interventions.
- Conservation agriculture is a very important area of research for agronomists. The effects of conservation agriculture in relation to nutrient-use efficiency and soil health need to be understood in greater depth.
- The experiences learnt from National Initiative on Climate Resilient Agriculture (NICRA) villages need to be documented and disseminated to large areas.
- The proposed 'Delhi Declaration' based on the deliberations in this Congress will be very useful and prove to be a millstone in the history of Agronomy.

Dr. John Dixon expressed the need for conserving the water resources for agriculture and industries, and integration of agronomists and experts from other fields of science. He related the goals of agronomic research and the need to reach the grass root level of food production system. According to him, both India and US face many common problems in agriculture, though the socio-economic level and the scales may be different. He also made the following points:

- ACIAR is honoured to be associated with the organization of the Congress.
- Agronomists have made enormous contribution to world food security.
- Rice-wheat cropping system is important for food security in South Asia. Introduction of legumes is essential for the sustainability of this cereal-based cropping system.

- Perennial rice cultivation is practiced in China on thousands of hectares, which needs upscaling in other countries also.
- There is need to improve the science of Agronomy with field application, and with due consideration of all the opportunities available in other branches of science.
- There is need to educate the next generation of farmers and share knowledge, and provide a new orientation to the future of agronomy.

Dr. R.S. Paroda emphasized the resilience of Indian agriculture and related the need for balanced approach in nutrition of plants as well as people, small farm mechanization, shift in research focus from crop-oriented to farming system-oriented, and innovations on conservation agriculture. The green revolution filled the plates with food, but today bulk food needs to be fortified with nutritious one. He stressed on the following issues:

- Farmers' income cannot be doubled unless new agronomic technologies are developed and adopted.
- Green revolution technologies have served well for over 3 decades. Now, the farmers need a better knowledge and follow specialty agriculture.
- There is a need to promote urban / peri-urban agriculture and attract youth towards farming by adding value and money to agriculture.
- There is need of better agronomic practices for residue management. Rice residue burning needs to be stopped.
- Zero-hunger challenge needs to be met not only in terms of food but also nutrition.
- There are better opportunities now to make *rabi* crop production more climate resilient due to better environment than *kharif* crops which are vulnerable to drought, flooding etc.
- Reorient the research agenda from crop/commodity-based to farming system-based approach, which also needs to be linked to the market and local conditions.

- New opportunities in resource management, i.e. conservation agriculture, protected cultivation, organic farming, container agriculture, terrace farming, and crop diversification need to be explored and promoted on large areas.

Dr. Paul E. Fixen stressed on quality science in Agronomy and application of the technologies developed for solving the problems of farming community. He informed that the American Society of Agronomy (ASA) has focused its activities on the following four goals:

- Facilitating good quality science in agronomy
- Agronomic research should have practical applications in the field, not just publishing papers.
- Growth of the profession for helping the farming community
- Meeting the needs of the individuals.

Prof. M.S. Swaminathan congratulated the efforts of Indian scientists in keeping the flag of green revolution high. He stressed upon the need for judicious use of resources, conservation and nutrient- and product-based strategy of food production system. He also stressed that an agronomist can help in realizing the potential yield of a variety through better management practices. He cited the example of stubble burning in northern India as wastage of resources, which otherwise could be turned

into wealth. Prof. Swaminathan urged to act fast and recommend package of practices in real time to address the need of the hour. The following issues were raised by him:

- Potential of new varieties of crops can be realized only by improved agronomy. Agronomists have played a key role in the past and I salute the agronomists present here.

- Country is now moving from food security to nutritional security.
- Irrigation agronomy needs to be oriented towards realizing 'more crop per drop', with due emphasis on water harvesting.
- Soil health card alone is not sufficient. There is a need for nutrient-based subsidy and promoting balanced fertilization, especially in the states like Punjab and Haryana, where the farmers are using more of urea fertilizer.
- Crop insurance scheme needs to be revised.
- Climate change issues are real. An increase of 1^0C in temperature may decrease wheat production by 6-7 million tonnes.
- There is need to increase productivity in perpetuity.
- Green revolution has been criticised on two accounts: (i) only rich farmers have benefited, and (ii) overdrawing of the ground water.
- There is 8000 km of shore line in the country. Rise of sea water due to climate change will render people along the coast as 'climate refugees'.
- Public policy must be guided by the scientists.
- We should focus not only on the economic part of the rice grain but also the byproducts like rice straw, husk, bran etc. for full utilization.
- Pulses bio-parks are being developed in south India for augmenting the production of pulses.
- According to Dr. Rattan Lal, Indian soils are getting deprived of soil organic carbon, which must be nourished.

Dr. Gurbachan Singh delivered the Presidential lecture and made the following key points:

- Climate change effects in terms of high/ low temperatures, cyclonic cycles, tsunamis etc. are now being increasingly realized on crops, and there is urgent need to develop couping up strategies.
- Water management issues require urgent attention including reuse of waste waters in non-food crops and timber plantations. Conjunctive alternate use of underground, surface and rainwater need standardization.
- *Prosopis* and *Opuntia* are the typical examples of drought-tolerant species and need to be promoted.
- Drought occurrence is likely every year, for which a long-term strategy that is climate resilient must be developed and promoted. Contingency planning and establishment of seed, fodder and water banks in drought-prone areas is the need of the hour.
- Cactus is a commercial crop in several countries like Mexico, Brazil, Argentina, Italy and South Africa. It is used as excellent fodder, food and medicinal crop, and hence needs exploitation in other arid and semi-arid areas of the world.

- Lands degraded due to sand mining and shifting cultivation must be restored through soil management technologies and alternate farming systems, such as silvipasture, horti-pasture and agroforesty.
- Agronomists should work not in isolation but in collaboration with other branches of agricultural sciences.
- Nutrient management should be based on *ex-situ* and *in-situ* generation of nutrient sources. Composting technologies for available biomass should be promoted. Time has come to generate sufficient organic manure/compost *in-situ* to substitute fertilizers which are becoming costlier day by day.
- Current status of nutrient-use efficiency (NUE) in Indian agriculture is very low. Several technologies for improving NUE are available but their adoption on the farmers' fields is low.
- Most of the herbicides are eco-friendly but may also have residue hazards besides development of herbicide resistance in weeds. There is a need to develop cost-effective integrated weed management technologies for their judicious use in agriculture.
- Good agronomic practices like conservation agriculture, direct-seeded rice cultivation, intercropping, planting multipurpose trees along field boundaries, pulses on field bunds, and others should be promoted.
- In areas of less than normal rainfall, there is an opportunity for pulses and oilseeds in place of crops like rice.
- Conservation Agriculture (CA) systems have worked in all kinds of environments around the globe. However, the area under CA is not increasing in India at the rate it should have increased.
- Innovative technologies like hydroponics, aeroponics, terrace farming, nanotechnology, transplanting of pulses like pigeonpea, should be developed and promoted.
- The ultimate message was to improve the resource-use efficiency i.e. 'more from less for more', 'conserve and grow', and develop technologies, which are 'pro-poor', 'pro-women' 'pro-small holder' 'pro-nature', and sequester carbon at field and village level.

EVENING LECTURES

Four evening lectures were delivered by outstanding scientists. This major highlights of the presentations are given below:

Evening lecture - 1

Prof. M.S. Swaminathan delivered a lecture on "*Farming System for Nutrition (FSN)'* to address the challenge of zero hunger. He highlighted the global issues of 'Food for All' in the anthropocene era, genetic erosion, food and nutritional security including Green Revolution in 1960s and National Food Security Act-2012. For achieving evergreen revolution, mainstreaming ecology in technology development

and dissemination is vital. He highlighted the UN vision of the five pillars of zero hunger challenge: (i) 100% access to adequate food all year round, (ii) zero stunted children less than 2 years of age, (iii) 100% increase in smallholder productivity and income, and (iv) zero loss or waste of food. The three major dimensions of hunger are: (i) calorie deprivation, (ii) protein deficiency, and (iii) micronutrient deficiency. The FSN involves the introduction of nutritional criteria in the selection of the components of a farming system involving crops like pulses, farm animals and fish. While finalizing the components of a farming system, the gender and age dimensions of human nutritional needs are kept in view, such as the special needs of pregnant women and nursing mothers, and new born babies. Biofortified crop varieties need introduction in FSN wherever available. Prof. Swaminathan suggested that there should be pulses revolution to address protein hunger, biofortification through breeding, genetic garden of biofortified crops, seawater farming, protecting cultural diversity and agro-biodiversity. For ending the alarming state of malnutrition in India, there is a need to bring together agriculture, nutrition and health. Prof. Swaminathan highlighted the major challenges for achieving zero hunger, avoiding food losses and food waste, climate change, increase in temperature, precipitation, and sea level, shrinking per capita land and water resources, feeding for high yield, expanding biotic and abiotic stresses, adverse cost-risk-return structure of farming, market volatility and reluctance of youth to take up farming.

- India has come a long way since the days of Bengal famine in 1942-43 to the National Food Security Act of 2012 by adopting synergy between technology and food policy.
- Farming Systems for Nutrition (FSN) is the new mantra for achieving food, nutrition and health security.
- There is a need to look at the full utilization of whole biomass production at the farm.
- Pulses *Panchayats* are a novel way of enhancing pulse productivity during the International Year of Pulses – 2016.
- Non-GM methods of achieving novel genetic engineering such as clustered regularly interspaced short palindromic repeats (CRISPR) are available now, which are considered as a major breakthrough.
- Genetic gardens of biofortified crops such as Fe-rich bajra need to be established.
- Sea water level rise due to climate change is emerging a treat to coastal farming systems. There is a need to conduct anticipatory research on such problems.
- Sea water constitutes 97% of the world's water resources. Silvi-aqua-agriculture models such as those of coconut-rice-fish need to be developed for areas below sea level such as the Kuttanad region of Kerala.
- Agronomists can help in improving productivity and profitability through intercropping systems such as Vanilla + *Gliricidia*.
- Bring together agriculture, nutrition and health for ending the alarming state of malnutrition in India. We must avoid food losses and food wastes.

- Agronomist must follow the farming systems approach to promote food, nutrition, health and livelihood security.

Evening lecture - 2

Dr. R.S. Paroda in his lecture dwelt upon '*Scaling natural resources management innovations for sustainable agriculture'.* He highlighted that the today's agriculture is in the midst of storm challenged by climate change, land degradation, loss of biodiversity, food crisis, energy crisis and population explosion. To liberate the developing world especially south Asia and Africa from twin scourge of hunger and poverty, we need to imagine a different world with better and healthy natural resources for our children and their children where hunger and poverty have been eliminated. Hence, while conserving the natural resources and meeting the needs and aspirations of resource-poor smallholder farmers, we need strategies and greater investments on NRM innovation-led accelerated and sustainable agricultural growth and achieving Sustainable Development Goals (SDGs). The 'GCARD Road Map' highlights the urgent changes required in Agricultural Research for Development (AR4D) systems globally to address goals of reducing hunger and poverty, while ensuring environmental sustainability and meeting the needs of resource-poor smallholder farmers and consumers. This requires major thrust on innovations for greater impacts on small-farm holder. The strategies for sustainable natural resource management are: scientific landuse planning, conservation agriculture, precision water and nutrient management, farming systems approach, climate smart agriculture (sustainable agriculture + resilience-GHG emissions), and strengthening collaboration and partnerships. He emphasized for upscaling of innovations, such as AFEX (An Innovation to Upgrade Cereal Straws), relay planting of greengram in wheat, sustainable intensification of cotton-wheat system with CA, precision water and nutrient application like sub-surface drip (SSD) irrigation system in CA-based rice-wheat system, protected cultivation etc. The changing paradigms are: enabling environment for scaling innovations, public-private-partnership (PPP) for product delivery, on-farm participatory research for natural resource management, capacity development especially of women and youth, linking small holder producers to markets – IMOD and impact assessment.

Out-scaling of relevant innovations for greater adoption and impact on smallholder farmers has emerged as a major challenge. There should be three pillar strategy, i.e. germplasm improvement, policy and socio-economics, and natural resource management. The polices for scaling innovations are: remove difficulties in enforcing legal intellectual property rights; target input subsidies towards pro-poor, input-use efficient and climate-smart technologies; reward researchers to commercialize their technologies; enabling environment for scaling of innovations through PPP for product delivery. He opined that agriculture can liberate people from hunger, malnutrition and poverty, and also bridge the widening income divide between rural and urban people. With declining land, water and agro-biodiversity resources besides adverse impact of climate change, the task ahead is quite difficult but not insurmountable. He recommended that there is need for: (a) reorientation towards

integrated farming systems research ensuring farmers' participation, (b) greater emphasis on scaling innovation for impact, (c) a foresight, faith in science and create enabling policy environment with increased funding support and building new partnerships with better coordination, and (d) convergence for technology transfer, which will ensure a better future for a younger generation.

Evening lecture - 3

Dr. John Dixon delivered lecture on '*The future of sustainable intensification and diversification for different rural environments*' focusing on the food-energy-water nexus, contrasting environments, farming systems, and global strategy for sustainable intensification and diversification. He dwelt upon issues related to energy and water for farming. Dr. Dixon emphasized the institutional context of Sustainable Intensification and Diversification (SID), which necessitates classification and mapping of farming systems. SID and farming systems include field system, farm system and farming system. The relevant farming systems approaches include traditional, quantitative systems modelling and farming systems for policy and planners. Farming systems need to be differentiated for simplified broad categories or zones of farming systems, each with broadly similar development needs, crops, livestock patterns and market linkages and describing internal variability. The foresight dialogues are essential for population, hunger and poverty, natural resources and climate, energy (renewable and non-renewable), human capital, knowledge sharing, gender, technology and science markets and trade (including agribusiness), and institutions and policies. The future of farming systems research and development for SID need to address complex problems, careful selection of actions to leverage multi-functionality of full farming system for sustainable incomes, nutrition and rural economic growth and inter-scale interdependencies and linkages.

Evening lecture - 4

Dr. Fixen made a presentation on "*Making waves … Einstein's lessons for Agronomy*", and suggested that substantial scientific contributions from Agronomy are needed to meet the zero hunger challenge. Evidence-based agronomy seeks the transparent integration of all relevant data and resulting recommended practices with local farm conditions and associated data. It has the potential to make the

science supporting agronomy more swift, nimble and credible, and can increase the impact of the data of agronomic science in a big data world. Implementation of evidence-based agronomy involves improvements in data stewardship and in the suitability of articles for synthesis of detailed reviews and analysis.

Dr. Paul E. Fixen quoted from the Einstein's lessons on 'Theory of Relativity' and connected its relevance to evidence-based agronomy in the present context. Our knowledge of practices, products, impacts and system advances one study at a time, which allows new study to be connected to the previous one and those yet to some. Further, the published articles list several authors for collaborating and sharing ideas and data. This suggests a key role for the agronomists to promote such collaborations and build personal relationships for making waves to advance and apply the science of Agronomy. Such initiatives have been taken through the joint activities of ASA-CSSA-SSSA though on a limited scale due to lack of awareness among the members.

Dr. Fixen cited examples from his own field of specialization of soil fertility and plant nutrition, and suggested that there are great opportunities for improving data stewardship and evidence-based approaches. 'Nutrient expert' has been developed as a decision support tool based on sharing of aggregated data from numerous researchers for generating guidance on source, rate and timing decisions on farms in Asia. This provides more profitable and efficient recommendations than the existing alternatives.

In conclusion, Dr. Fixen suggested that evidence-based agronomy has much to offer our quest for the sustainable management of natural resources, environment, energy and livelihood security to achieve the zero-hunger challenge. This requires viewing data as a primary product of science that grows in value with accessibility and with time, and seeing each new research contribution as a continuation of the discovery process and not just as an independent event. We need to adopt it by sharing and publishing quality data sets with essential meta-data and professionally recognized data contributions. Further, we also need to train young scientists and students in data stewardship, systematic reviews, and meta-analysis.

PLENARY LECTURES

Eight plenary lectures were delivered by eminent scientists. The major highlights of the presentations are given below:

Plenary lecture - 1

Dr. Trilochan Mohapatra presented his lecture on "*Climate Resilience and Sustainability of Indian Agriculture: Challenges and Opportunities*". He informed that 4.4 million tonnes of basmati rice was exported in 2015-16 and total export of rice reached 11 million tonnes worth Rs. 43,000 crores. He informed that world's population will reach 9.2 billion and to feed this population, food production must increase and diversified farming must be adopted. He highlighted the context and concerns with an idea of "*More from less for more*". In India 85% farmers are

small and marginal, who have limited resources. Climate change has become a major bottleneck for achieving increased productivity. He emphasized that we have to deal with increased cost of production, and scarcity of water and other resources. Agriculture is stressed due to climate change, scarce natural resources and biotic stresses. We need to focus more on secondary agriculture and specialty agriculture which can lead to sustainable food, nutrition, health, environment and employment. He emphasized on one health, i.e. human health, animal health, plant health and soil health. Agronomy has a special role to play for improving both plant and soil health, and food and nutrition go hand in hand. Indian agriculture is monsoon dependent. This has made us more vulnerable because of close link between climate and water resources, and the need for diverse farming system. Sustainable agriculture is the production of food, fiber or other plant or animal products using farming techniques that protect the environment, public health and human communities.

Dr. Mohapatra stressed the need of making our agriculture more climate resilient and sustainable through the conservation of plant genetic resources, agro-biodiversity and identification of donor lines in crops. He shared the success story of Swarna Sub-1, the submergence-tolerant rice variety for eastern India and waterlogging-tolerant varieties of pulses (pigeonpea, blackgram and greengram). He highlighted the need for development of stress tolerant and climate resilient lines. Development of climate resilient GM crops is also a viable option, e.g. Bt cotton with stress tolerance for nutrient uptake and utilization efficiency with low environment footprint. Research on evolution of pathogens under climate change should be a priority. He shared that 151 climate resilient villages have been established and resilient indicators in NICRA villages have been identified.

Dr. Mohapatra emphasized the adoption of integrated farming system, smart farming using smarter and new techniques, and weather-based support systems through space applications. He emphasized the need for assessment of several water-saving technologies under different agro-ecologies, large scale replication of climate resilient and sustainable agriculture models, taking the science of climate resilience and sustainability to a higher platform, land consolidation, promotion of

self-sustaining seed system, creation of primary processing centre at production sites, and complete package for use of waste, and market linkage through agri-information and service centres. He appreciated the involvement of scientists under *Mera Gaon Mera Gaurav* scheme of the Council and opined that scientists should play the role of social change agents.

Dr. Mohapatra emphasized on the following issues:

- India supports a large proportion of world's human and livestock population despite limited resource base, which are now under serious threat.
- Agriculture is gradually becoming more climate resilient as we exported rice to the tune of 11 million tonnes despite drought in the recent years. We are lagging behind in pulses and oilseed production.
- Major challenges in the present context include 'more from less for more', starch to protein to health foods, climate change, increased cost of production, stress agriculture, shortage of labour, trade-market-price etc.
- India is one of the most vulnerable regions in the world as per the climate risk index, and we need to make agriculture more climate resilient and sustainable.
- Recent achievements in the development of submergence tolerant rice (Swarna Sub-1) and waterlogging tolerant pigeonpea are noteworthy.
- Despite the development of water-saving and conservation agriculture technologies, the adoption rates are low, which need to be taken up on large areas.
- Agriculture cannot remain subsistence any longer. We must make it commercial, profitable, sustainable and acceptable in future.
- Investment on agriculture research provides much higher returns despite low investments, which need to be increased further.
- We need to take the science of climate resilience and sustainability to a higher platform, and go for large-scale replication of successful agri-models. For this there is a need for creation of agri-information and service centers at every *Panchayat* level.

Plenary lecture - 2

Dr. Mathew Morell delivered his lecture on "*Rice-based systems research and meeting the sustainable development goal"*. Globally, rice is grown by 144 million small farms with a production of around 700 million tonnes, feeds 3 billion people, and home to 400 million rural poor (40% of world's poor). Rice cultivation globally receives fertilizers (15% of world's total) and irrigation water (35% of world's total). For catalyzing positive change, Dr. Morell suggested the followings: (i) understand the nature of the key constraints and unexploited opportunities, (ii) develop the package of technological solutions required to address key needs, and (iii) work through partners to foster implementation.

The breeding interventions proposed by Dr. Morell include stress-tolerant varieties (Germplasm x Environment), breeding for management (G x E x Management), and breeding for rice-based systems (G x E x M x S). Sustainable rice production indicators are: water and nutrient-use efficiency, food safety, pesticide use, GHG emission, women empowerment, child labour, worker health and safety, P-use efficiency, grain yield, profitability and land productivity. The policy areas identified for further regional collaboration include joint varietal evaluation and release, reciprocal recognition of evaluation data for similar agro-environments, reduce time for evaluation of varieties developed through MABC, acceptance of PVS as primary data for varietal release, pre-release seed multiplication and promotion, encourage private sector involvement, harmonize seed systems and policies, and germplasm exchange. He concluded that GIS/ RS technologies allow us to accurately target and prioritize on the basis of biological, biophysical, and socio-economic factors. Breeding for stress tolerance, management systems and markets reduces farmer's risk and increases resilience. Optimizing the rice component of a complex farming system is central to optimizing overall productivity, profitability, and sustainability. A new generation of decision support tools are available for supporting productivity and profitability. Research and delivery partnerships are critical to make a difference for farmers.

Plenary lecture - 3

Dr. David Bergvinson in his address entitled '*Sustainable management of natural resources for improving rural livelihoods and nutritional security*' expressed that honing of soft skills among rural populace and pragmatic policies should be adopted. Science should not be encased in the 'analysis-paralysis' syndrome. Innovation also should be demand-driven and the innovation through design-develop-delivery line will streamline the process of innovation. In this age, consumer preferred products, knowledge and services are in demand. The value system guiding the whole anthropocentric agro-activities must sustain the environment of trust and governance. Dr. Bergvinson expressed the need for dedicated agency for woman farmers and agro-entrepreneurs, and encouragement of youth to take up agriculture.

The role of private partners with public-funded organizations, the synergistic role of formal and informal sectors leading to correct innovation and speedy dissemination of technology was elaborated. He discussed the burning issues of water-smart agriculture and micronutrient deficiency mapping, and the need of recording water footprint of products as water is intricately related to climate change effects. There is urgent need of enhancing water-use efficiency, rainwater harvesting, and establishment of zero water loss irrigation systems.

Plenary lecture - 4

Dr. R.B. Singh in his plenary lecture titled '*Zero hunger India – the challenges*', narrated various facts and figures related to the enigmatic face of food production machinery of India. Despite showing astounding progress in food production and establishment of solid base of research over the decades, the gaps in addressing the issues of food availability in a holistic way sustained hunger of many kinds in our society. The country is the leader in horticultural and milk production, yet non-availability of quality food material points finger to gap in formulating policies which focus on the livelihood of smallholders. These smallholder farmers are the real bread winners of India. There is urgent need of fortification of bulk food with

vital nutrients either through breeding or value addition, minimize post-harvest losses and food wastages, and address decline in pulse production for closing the ever-increasing demand-supply gap in this era of climate change. Various research activities around the world are going on to develop climate proof varieties of rice. Apart from technology development of enhanced production in changing climate scenarios, the need is to refurbish the ecosystem of seed-to-plate route of food through inclusive market-oriented development. Dr. R.B. Singh narrated many examples of innovations to fight adverse climate as well as market, and lauded the role of private players in speeding-up the correction process of the food production programmes. The governments around the world should think of a common

command structure encompassing different ministries dealing with plants and animals to speed up the remedial measures in this fast changing climate and economy.

Plenary lecture - 5

Dr. Panjab Singh delivered a plenary lecture on "*Climate change and food security challenges – our preparedness*". He highlighted the resource crunch in food production sector, mainly due to anthropogenic activities and accelerated pace of climate change which will adversely affect the civilization. The ominous reports of drying-up of glaciers as predicted to happen within 2035 will affect riverine ecosystem and human settlements along major rivers. It will lead to catastrophic change in the Ganga delta as it may turn infertile. In India, around 40% decline in water availability is predicted in the coming decades. Besides, 50 million people will be displaced by flooding and inundation in the coastal region due to rising sea level. Already 92% of the world population is breathing bad air. It has been estimated that agriculture is contributing 17% of the total global warming potential. Amongst these, livestock is contributing 63%, while 21% comes from rice, and only 2% from residue burning. Dr. Singh suggested noteworthy innovations to reduce adverse impact of climate change, which include improvement and forecasting in early warning system, establishing hazards and vulnerability mapping, augmenting public awareness, creating community-based forest management and afforestation, improvement in irrigation systems and management, and diversification and design of crop production management systems. The Government of India, in its preparedness for impending climate change has initiated eight National Action Plans that include National Missions on Water, Green India and Sustainable Agriculture. Through National Initiative on Climate Resilient Agriculture (NICRA), technologies are being standardized for different regions along with spreading community awareness and increasing skill base through capacity building. Agronomists are to take a leading role in reducing the global warming potential contributed by agriculture.

Plenary lecture - 6

Dr. K.L. Chadha delivered a plenary lecture on "*Agricultural diversification through horticultural crops for nutritional security*". He described the horticultural infrastructure in the country and stated that starch-rich staple food fills the belly and the need to fulfill the micronutrient and vitamin requirement in each serving of the day has been overlooked for long. Increasing popularity of junk food among working people and youngsters is ruining the health of our future generation and giving rise to new life-style diseases. The hidden hunger for protective food needs to be eradicated to achieve the goal of zero huger. Eradication of malnutrition, a widespread and persistent global health problem in developing countries continues to exert an enormous toll on individuals, population and society. Three billion people are affected by micronutrient deficiency globally. The demand for fruits and vegetables is expected to be 124 and 189 million tonnes, respectively by 2020-21. The current production of these commodities is only 89 and 160 million tonnes. Proactive policies of the government have helped in enhanced investment in horticultural R & D, which has led to development of 808 varieties of fruits and vegetables in India. Further, new technologies like hybrid seed production, vegetable grafting nurseries, protected horticulture, vertical gardening, aeroponics and hydroponics have been developed to speed up production process and to economize space utilization. New crops like kiwi fruit, kokum and gherkin have been popularized in the country for production as well as export. New climate resilient varieties of different vegetable crops have also been developed. Further, innovative hi-tech technologies like high-density planting of fruit crops, canopy architecture management, and customized micronutrient mixtures have been developed. Value addition and preservation technologies have reduced post-harvest losses to a considerable extent. To combat the micronutrient malnutrition, Dr. Chadha suggested development of nutrient-rich and pigment-rich varieties following biofortification and biotechnological interventions. He further stressed upon the concept of nutrition garden, promotion of peri-urban horticulture, and introduction of fruits and vegetables in mid-day meal programme for school children as well as in the fast food chain.

Plenary Lecture-7

Dr. Ramesh Chand delivered a talk on "*Dietary diversification in India: Implications for agriculture R&D*". He made the following points in his address:

- Sustainable Development Goals (SDG) of UN have been adopted by 193 countries of the world. In India, the responsibility has been given to Niti Ayog to achieve these goals by 2030.
- Goal of all agriculture R&D in India is to ensure food and nutritional security.
- After the green revolution, India became a super power and we proved everybody wrong.
- Nobody believed that a largely vegetarian country like India will become the largest meat exporter.
- After WTO, Indian agriculture progressed tremendously and the exports doubled compared with the world's average.
- Nutritional outcomes are different from economic outcomes. Impressive growth in income and reduction in poverty occurred during the period from 1993-94 to 2011-12, but still undernourishment is stubbornly high.
- Current total food production is 726 MT (million tonnes), which includes 544 MT from plant origin and 181 MT from animal origin. The estimated demand by 2031-32 will be 1026 MT. Required growth rate is lower than the achievements of the past

- Implications for agricultural R&D involve genetic manipulations through conventional breeding, genetically modified organisms, and gene editing. There is public sensitivity involved with GMOs, which is not likely to be settled soon.
- Production agronomy involving precision farming has a great scope. This is required for better production with lower wastage of food.
- More than 60% area remains without crop for 7-8 months in a year. Even irrigation has not improved the cropping intensity.

- Agronomy has to play a much bigger role in future farming. Agronomists need to focus on evergreen revolution, improving nutrition and enhancing farmers' income.
- Precision farming, fertigation, laser land leveling, precision seeders and planters, direct-seeded rice, zero-tillage, raised-bed, ridge planting etc. are great ideas for the Agronomists.
- Agronomy can provide solutions and we must take the technologies to the farmers.

Plenary lecture-8

Dr. J.S. Samra delivered a lecture on "*Nexus among poverty, hunger, water and energy in India*". He made the following points:

- India stands poorly on Global Hunger Index (GHI), which is based on the parameters of nutrition, age, height and weight of the children.
- Since the major economic reforms of 1991, poverty reduced by 39% and GHI by 19%. The contribution of agriculture to GDP reduced from 30 to 13%. However, >50% of the work force is still dependent on agriculture.

There is negative relationship between irrigation and rural poverty. As the irrigated area increases, the rural poverty decreases. Similarly, as ground water development increases, the poverty decreases. As irrigated area increases, the GHI decreases. Also as electricity increases, the rural poverty decreases.

Our challenges include:

- Poor capita land availability has declined and it will continue to decline.
- Solar and wind farming is appearing as a unique challenge to the limited land resources.
- Private sector has already stated leased land in Punjab for solar farming.
- Agri-voltaic systems of intercropping with solar and wind farming are being experimented.

- Eastern India receives 3 times more rainfall and very good quality water but the ground water exploitation is very poor.
- Efficiency of canal irrigation is about 37%, and that of wells and bore wells is 60%. It is a major issue of governance.
- Canal irrigation system in Gujarat is designed for micro-irrigation.
- In Rajasthan, there is low density of population, and therefore, non-grid based electricity is costlier than grid-based approach.
- In the high rainfall areas of eastern India, multiple use of water and fish-based farming systems have high B:C ratio.

In conclusion:

- Complicated nexus among poverty, hunger, water, energy and other technological inputs and social sector investment reduced poverty and hunger for realizing SDGs in rural sector.
- For agriculturists, solar farming through agri-solar systems is an important avenue.
- There is a long way to go for achieving zero hunger in India.
- Eastern region of the country holds great scope where the ground water exploitation is low, water quality / rainfall are very good, and rice fallows occupy >10 M ha.
- In command areas, micro-irrigation should be promoted on at least 50% area.
- Maharashtra Government has formed a law that sugarcane must be grown with drip irrigation only.
- The role of agronomy is very important for checking unhealthy nexus among poverty, hunger, water and energy in India.

SYMPOSIA

Twelve symposia on the main theme of the congress were organized. The highlights from these symposia are presented below:

Symposium I: Climate Smart Agronomy

- The projected impacts of climate change on agriculture pose a serious concern to future food security and warrants immediate actions to prioritize investments on massive scale and innovations in climate smart agriculture practices.
  - If 100% cultivated area in India is laser lavelled, total national level GHG saving from this technology will be 6668 Gg CO_2eq/yr (1520 Gg due to less power requirement for irrigation, 188 Gg due to less power requirement for field preparation, and 4960 Gg due to 10% fertilizer saving).
  - If Government's directive to produce 100% domestic urea as neem coated is realized, total GHG saving from this will be 9353 Gg CO_2eq/yr (0.12%

less N_2O emission from neem coated urea than normal urea). (1 Gg = 1000 tonnes)

  – Government can take advantage of the mitigation fund (e.g. GCF or CDM) for doing the activities which are already in its priority. All it needs to say is that both adaptation and mitigation are national priorities.

- For making agronomic innovations relevant to the needs of farmers, systems research is the key, and the cropping system modelling extends and enhances relevance of traditional agronomic research. To understand likely effects of future climate on the current and alternative management practices, cropping system models such as APSIM may help to compare alternative cropping systems and quantify their value across different metrics.
- Portfolio of agronomic practices has synergistic and complementing effects rather than they are applied in isolation. For example combined use of laser land leveling, zero tillage, improved variety, precise nutrient management (nutrient expert and green seeker) increased the net returns by 95 and 65%, respectively in rice and wheat coupled with higher partial factor productivity of N, which could be less than sum of all when applied in isolation.
- Non-linear models and approaches of technology delivery including technology-led businesses and service windows should complement the existing public extension system for last mile delivery of climate smart agronomic innovations and their impact at scale.

Symposium II: Organic Agriculture

- Progressive adoption of integrated crop management “towards organic” approach for intensive agricultural areas largely functioning as food hubs and “certified organic farming” with combination of tradition, innovation and science in the prospective organic areas (hills), rainfed/ dryland regions and niche crops (that respond positively to organic management) have the potential to augment safe food security and climate resilience, besides enhanced income of farm households. This approach will also benefit human, livestock and ecosystem health, the basic objective of organic agriculture.
- Modern organic agriculture is not the same as in 1950s. Despite virtually no investment in research and inputs, organic farming seems promising option.

Increased fund allocation towards strengthening research in organic farming is highly desirable.

- Though on-going efforts are scattered, much remains to be done towards inclusion of organic farming in the curriculum of UG programmes in the NARES universities and institutions. Research on various aspects of organic farming (crops and livestock) must be initiated at PG level and beyond.
- Organic farming has an estimated market size of US$ 80.0 billion (6 times over 1999) and has been growing @ 170% over 2002. It has the potential to generate employment with immense scope for specialty organic products.

- Government of India is extremely concerned about the soil health status *vis-à-vis* production of quality food for promoting organic farming in rainfed and hilly areas where fertilizer consumption is low through various schemes/ programmes under National Mission for Sustainable Agriculture (NMSA)/ *Paramapragat Krishi Vikas Yojana* (PKVY), *Rashtriya Krishi Vikas Yojana* (RKVY), and Network Projects on Organic Farming and Network Project on Organic Horticulture of ICAR. Government is implementing a cluster-based programme to encourage the farmers for promoting organic farming under PKVY. It is recommended that the subsidy being provided to the farmers for practicing conventional agriculture must be extended to the organic farming practitioners as well. The process of certification of exportable commodities also deserves to be subsidized in view of the exorbitant costs involved.

Symposium III: Agriculture Diversification for Sustainable Resources

- Agricultural biodiversity has hitherto been valued almost exclusively as a source of traits that can be used in scientific breeding programmes to improve the productivity of crop varieties and livestock breeds.
- A wider deployment of agricultural biodiversity is an essential component in the sustainable delivery of secure food supply. Diversity can maintain and increase soil fertility, and mitigate the impact of pests and diseases.
- Agricultural biodiversity is essential to cope with the predicted impacts of climate change, not simply as a source of traits but as the underpinnings of

more resilient farm ecosystems.

- Agroforestry systems entail the purposeful growing of trees and crops, and sometimes animals in interacting combinations for a variety of objectives on the same unit of land.
- Crop rotation, reduced tillage, cover crops, fallow periods, manuring and balanced fertilizer application can help to maintain and restore soil fertility. The intermingled planting of crop genotypes that have different disease-resistance profiles can decrease or even effectively eliminate a pathogen.
- Farming system approach is a powerful tool for natural and human resource management. It is a multidisciplinary whole-farm approach and can be effectively employed in solving the problems of small and marginal farmers. The approach aims at increasing employment and income from small-holdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself.
- Intensification and diversification especially with pulses, oilseeds, forages, and agroforestry can maintain soil health in reducing the carbon footprint of the entire agriculture production system.
- Inclusion of aromatic crops in traditional cropping system can significantly improve economic returns while providing several ecological benefits.
- Aromatic plants have shown to provide economic advantages when included in plantation crops, horticultural crops, agroforestry systems, and in the traditional food cropping systems in Indo-Gangetic plains.
- Rice-rice, rice-rice-rice, rice-wheat, rice-maize, maize-wheat, rice-pulses, rice-vegetable, millet-wheat, rice-potato and cotton-wheat are the predominant cereal-based systems in the IGP. Conservation agriculture is a concept for optimizing crop yields, and economic and environmental benefits in these systems.
- With technological and infrastructural development, numerous hill and mountain farming systems have emerged in India. The resultant higher productivity and profitability under various models through crops and farm enterprises strongly advocate to follow IFS principles and technology in hill

production systems. These interventions will transform the less remunerative hill production systems into highly remunerative systems using available farm resources to generate better farm gains, climate resilience, livelihoods and employment on sustainable basis.

- Resource inventory of the site will play lead role in site-specific science-based crop diversification in the era of economic reforms with *particular* reference to crop production enhancement which spread risk and optimization of income through *diversification.*

Symposium IV: Integrated Farming Systems for Small Holders

- Farming systems are complex and diverse. To develop appropriate adaptation strategies and alternative farming systems, diversity needs to be captured. Through modeling, farming systems analysis allows exploring and assessing future plausible scenarios in terms of the multiple objectives pursued by farm households. Therefore, a dedicated farming system modeling consortia should be established to handle the vast, diverse and complex farming systems.
- Farming systems are highly location-household-resource- and management-specific. Farming systems research should focus on innovative (diversification) and holistic (improvement of existing) approaches. Appropriate statistical methodology, tools and sustainable farming system indicators need to be developed.
- Farming system approach of agricultural development including farming systems for nutrition should be given impetus by developing integrating field crops + horticulture + livestock + fisheries + agroforestry + others (apiary, mushroom etc.) under one umbrella. Farming system models comprising these components promise to double the income of small holders in a short period besides improving nutritional security of farm families.
- Synergizing the schemes of Department of Agriculture, Cooperation and Farmer's Welfare, Department of Dairying & Animal Husbandry and Department of Fisheries are essential to reap the benefits of scientifically designed farming system models being developed by research institutions.
- Collective, cooperative and value-added farming systems should be promoted

by appropriate policies. There is a need to develop farming system models for one acre, one ha, and two ha land holding with the hypothesis to double farmer's income.

Symposium V: Abiotic and Biotic (weeds) Stress Management

- Climate resilient technologies modules and expansion of climate resilient village models developed by NICRA need to be converted into large platforms.
- Conservation agriculture systems need to be promoted with strong research-based strategic planning, particularly under rainfed and hill ecologies where soil loss is predominant.
- As continuous crop residue addition under CA systems improves the soil fertility, reduction of nutrient input doses, particularly K, P, S, Zn need to be examined and such recommendations need to be promoted. Benefits of CA systems need to be studied with degree of tillage and residue cover. Termite problem needs special emphasis in promoting CA systems.
- Large scale preparedness and implementation of contingency plans developed by the ICAR need to be taken on priority basis. Strong institutional set up at the centre and state Government level need to be taken up. ICAR along with NARS has developed contingency plans for 614 districts in India. Continuous updating and implementation is going on across the country for preparedness for deficient and excess rainfall, and real time responses.
- Land scape modeling, regional weather forecasting and decision support systems need to be promoted.
- Weed seedbank control needs more emphasis over weed management practices. Direct-seeded rice systems need special emphasis with respect to weed and water management.
- Saline and sodic soil reclamation process, and re-sodification patterns need to be studied in cropping system/agro-ecosystems.
- Integrated drought management systems with components of agro-advisories, drought-tolerant cultivars and efficient rainwater management need to be promoted for climate resilient agriculture and similar agro-ecosystems.

- Greening eastern India and dryland systems need to be taken up with technology back-developed programmes for future food security needs.

Symposium VI: Efficient Soil, Water and Energy Management

- Use of solar energy has to be emphasized to encourage solar farming. Appropriate policy support is needed to incentivize efficient use of energy in agriculture.

- Biochar prepared out of the residues through pyrolysis can be utilized for C sequestration. However, the benefits of biochar in soil health restoration and augmenting nutrient supply need to be investigated. Energy involved in pyrolysis should also be considered to evaluate economic viability of biochar preparation.
- Waste water treatment with low energy input is a challenge. The technology developed at IARI is economically viable, and can be validated and replicated.
- *In situ* water conservation technologies need to be generated and popularized. The farm pond technology needs to be critically evaluated to see if it encourages erosion and runoff within fields.

Symposium VII: Precision Nutrient Management

- Precision nutrient management is essential for producing more food from less land in environmentally sustainable manner.
- Significant knowledge gaps exist, and research investment is required to optimize source, rate, time and place of nutrient application in the following areas:
  - Diverse cropping systems of the region, and when crops are grown in sequence under anaerobic and aerobic growing environment.
  - Conservation agriculture systems with differential residue retention scenarios.
  - For adaptation/ mitigation of climate change impacts, such as drought, excess precipitation, heat stress and progressive N limitation.

- A multi-institutional consortium should be developed to focus efforts on convergence of precision nutrient management approaches adopted by different groups to synergize the benefits of individual efforts. This consortium can serve as the R&D engine to define systematically the most critical practices, and magnitude of the resulting impacts and adoption using approaches that integrate the socio-economic aspects of crop production.

- Public core funding is essential as a targeted initiative to provide momentum for such efforts.
- Satellite imagery, if available at low cost, can leapfrog the application of precision nutrient management strategies in smallholder systems. Concerted efforts are needed to integrate near real time imagery to nutrient management approaches to provide in-season flexibility to achieve productivity and profitability at scale under climate change scenario.

Symposium VIII: Conservation Agriculture and Smart Mechanization

- A multi-stakeholder conservation agriculture platform should be established at national and regional level (like rice-wheat consortium) to serve as knowledge repository, monitoring and evaluation centre, and policy think tank.
- Policy and institutional support should be mobilized to accelerate the spread of conservation agriculture. This includes research and education as well as the formation of farmer organizations and public-private partnership mechanism including the involvement of private sector.
- Conservation agriculture should be integrated as a core component of National Agricultural Development plans for sustainable intensification in all production sectors.
- Turbo/ happy seeder should be incentivized through diverting subsidy from other tillage implements, and technology user farmer rewarding system should be implemented.
- Conservation agriculture provides a roadmap towards agricultural sustainability with a global spread of >160 million ha including 5.6 million

ha in South Asia with documented benefits of productivity, economics and environment.

Symposium IX: Innovation Systems and Last mile Delivery

- In order to promote development of farmers-led skills as well as protect their rights, it is necessary to recognize and further promote these innovations. It is also desirable to blend the farmers' innovations with the modern scientific knowledge and properly upscale them for the benefit of farming community at large.
- Development of location–specific technology matrices by appropriate operationalization (essential and desirable conditions) at the micro-level involving relevant disciplines and stakeholders for optimal returns.
- Development of public-private, and private-private partnerships for technology generation and transfer in participatory mode
- Crop management research must be associated with relevant research on social, political and economic issues, for which extension education scientists should be involved as active co-workers in research in applied disciplines like agronomy, breeding, crop protection, etc.

- Participatory research needs to be given special attention to solve region-specific local problems by actively involving farmers as main actors in the research / experimentation process which will help not only to solve the problem but also help to diffuse such technologies.
- The researchers need to be oriented on systematics of carrying out participatory research especially with involvement of farmers and extension functionaries in the process of experimentation in the farmers' fields.
- Break disciplinary barriers amongst Subject Matter Specialists (SMS) by sensitizing for problem-solving approach, instead of disciplinary mode.
- KVKs/ regional research and extension centres should synthesise the relevant technologies and communicate to the farmers through electronic / social media, and also work closely with extension functionaries of line departments to train them not only on what technology but also on why and how to effectively communicate.
- A national innovation cell as a hub of knowledge dissemination through the network of ATARIs and KVKs involving scientists, policy makers, extension experts as well as farmers from different parts of the country should be created for scaling-up the innovations through collection, validation, rectification, commercialization and dissemination of farmer-led innovation.
- Contents of mass media channels, ICT applications (portals, mobile apps, alerts, SMS, advisories on crops, weather, markets etc.) should be made more specific to the region.
- Introduce policies and institutional mechanism to induce farm innovations and adoption of 'Good Agricultural Practices' instead of 'package of practices'.

Symposium X: Livelihood Security and Farmers' Prosperity

- All efforts should be targeted for sustainable transformation of agriculture, which should entail addressing the impediments, harnessing growth opportunities and empowerment of people working in agriculture. Agriculture should become efficient, globally competitive, sustainable, climate resilient and agribusiness- friendly. There should be particular emphasis on sustainable use of land, water and other natural resources.
- Agricultural diversification and value addition can substantially increase farm income. There should be development of value chains and linkages of farmers with markets. This shall require more investment, access to post-harvest technology and quality raw material. Enhancing productivity, risk management and promotion of value chains shall also need addressing the issues of last mile delivery of services through horizontal and vertical linkages with different institutions.
- Integrated farming system comprising field crops, horticultural crops, livestock, fisheries and other secondary activities has great potential for increasing farm income by 3-4 times in irrigated regions. Small and marginal

farmers have advantage in promotion of integrated farming. Technical support, access to credit and markets, and risk management are essential for promotion of integrated farming. There are some success stories in this regard, which must be replicated for wider impacts.

- Nearly half of farm household income comes from crops and livestock in the SAT region and the rest from non-farm activities. Household income is also positively correlated with multiplicity of income sources and crop diversity, and therefore, non-farm activities are important for increasing farm household income.
- Energy use, production cost, productivity and income are positively associated. Therefore, increase in crop productivity would require access to capital and commercial energy. It is estimated that energy requirement will double if the low productivity states are needed to achieve the national productivity levels.
- Farmers' access to technology and associated inputs, policy environment and institutional change must support agricultural transformation and promotion of sustainable and integrated farming systems. In this context, sustainable farm practices and packages for different agro-climatic assume significance.

Symposium XI: Emerging Challenges for Agronomy Education

- Agronomy education should not be tight jacketed but go beyond its boundaries to address emerging issues of climate change and weather vulnerability, conserving and improving degrading natural resources, sustainability and others. There is a need to restructure the syllabus and improve the course contents to make it more relevant and responsive.
- Agronomic research is required to reorient research strategies towards changing regional, national and global needs, and work out new strategies to integrate knowledge, skill, ability and experience in total process of research.
- There is a need for multi-disciplinary and cross-disciplinary research to give total solutions to the problems.

- There must be a balance between theory and practicals, especially hands on training / experiential learning, addressing the issues of gender biasness, combination of tradition, technology, talent and trade in agronomy education.
- Policy is required to: (i) organize brainstorming sessions for integration of teaching, research and societal needs, (ii) working out strategies to produce more with less resources, (iii) strengthening agronomy education in specialized disciplines like crop nutrition, soil fertility, weed management, water management, crop production, etc., (iv) focusing agronomy education towards management of natural resources, environmental sustainability and food security; (v) enhancement in institutional support for carrying out quality of PG teaching and research, and (vi) designing and introducing new courses, especially in agro-ecology, environmental science, agroforestry, food and nutritional security, climate adaptation etc.

Symposium XII: New Paradigms in Agronomic Research

- 'More from less for more'. 'For more' signifies rising population, rising demand for cereals and animal food; while 'less' means decreasing arable land area, productive quality of soil, physical water scarcity, groundwater depletion and rapid biodiversity loss.
- Green revolution of 1960s was achieved through application of science and technology in well-endowed areas. Dry and marginal areas now offer opportunity for harnessing their potential, for which technologies will have to be developed. This can be achieved through advances in science and technology, integrated approaches for natural resource management, sustainable intensification of production systems, institutional support and capacity development.
- Research agronomists need to have capacity to tackle emerging problems through integration of the pillars of sustainable agricultural development. Agronomists need to work with plant breeders to develop high productivity and stable yielding genotypes containing climate smart traits.

- Natural resource management requires technologies for appropriate soil management, integrated water management, farming systems, participatory on-farm research and large data handling.
- Farm mechanization is needed for small holder farmers to practice conservation agriculture, and alternatives to mechanical and herbicidal control of weeds.
- Agronomic research is needed for protective agriculture and solar farming. A research agronomist need to have good understanding of climatology, plant physiology, soil physics, soil microbiology, soil fertility, farm mechanization, agricultural economics, participatory approaches and large data handling.

SPECIAL SESSIONS

Four special sessions were organized. The highlights from these sessions are given below:

Special Session I: Youth and Agriculture: Challenges and Opportunities

- Agriculture needs quality youth and but the current AR4D agenda is an incremental innovation and not attractive to quality youth. Therefore, there is need for transformational innovation through trans-disciplinary and trans-stakeholder approach at different levels, i.e. redesigning agricultural education system for entrepreneurship and just not only for research and extension. There are serious gaps in understanding the skill needs of agricultural sector. Therefore, a mission is needed to identify and prioritize skill needs, and institutionalize these to impart knowledge to youth for attracting quality youth to agriculture.
- Focused attention on capacity development of youth through vocational trainings, inclusion of agricultural education in school curriculum and farmers participatory approach for technology generation, transfer and adoption is needed to ensure faster growth in agriculture.

- To make agriculture intellectually interactive and rewarding for youth, special emphasis is needed on secondary agriculture, diversification, protected cultivation, crop intensification, service providers, and use of ICT in agriculture.
- Higher investments are needed to motivate young professionals to adopt agriculture as a profession, create more job opportunities in agriculture, and develop agriculture on lines of industry so that youth in future become 'job creators' and not 'job seekers'.
- It is high time that we involve youth in decision-making processes both for research and development programmes at the national, regional and global levels.
- There is an urgent need for strong political will and enabling policy environment for greater involvement of youth in AR4D initiatives. For this, there is a need to focus more on foresight, research partnership and capacity development.

Special Session II: Big Data and Evidence-based Agronomy

- Better understanding of data management protocols, repository of data for archiving, proper analysis, and access to data is essential for developing broader conclusions out of regional agronomic data.
- Data management, specifically proper data acquisition and their safe keeping, is a neglected area of agronomic research. A concerted multi-agency effort is required to develop appropriate protocols of data management and inter-agency access to benefit from the big data generated through public funding.
- Appropriate policy is needed to ensure access to data from public-funded projects within a specified period of time.
- Knowledge on agronomic data management and analysis needs to be a part of the agricultural education. A data management course should be included at the post-graduate level in agricultural universities. A multi-agency committee needs to be formed to develop the framework of the course content.

- Knowledge exchange on data management with similar established initiatives like "Purdue University Data Repository" should be explored to ensure access and inter-operability of public core funded data for greater societal benefit.

Special Session IV: Scaling Agronomic Innovations in Cereal System of South Asia

- Innovation-led, business-allied, service-centric, foresight-based, multi-linear technology delivery and adoption models should replace or complement the existing public sector led extension systems. This would require skill development and confidence building among stakeholders to achieve the last mile delivery.

- Futuristic agronomy needs transformational innovations through trans-disciplinary research for development, integrating ecology-specific components of different technologies as conservation and precision agriculture, SRI, SSNM, SSWM etc.
- Innovations as conservation agriculture, SRI, and site-specific nutrient management have produced several success stories which are based upon

scientific evidences. However, adoption by farmers is slow as the site-specific refinement is needed, which should be done with the involvement of farmers.

- Upscaling agronomic innovations is a long-term business with clear evidences from South American countries, where adoption of conservation agriculture took >30 years. This technology dissemination and adoption business model suggests partnership and participation of all stakeholders including farmers and private sector to reduce the gestation period of any technology.

PANEL DISCUSSION

A panel discussion was held on “Doubling Farmers’ Income by 2022". Six speakers presented their views on the topic. The following points emerged from the discussion:

- Income of the farmers can be enhanced by reducing cost and enhancing productivity. Varieties tolerant to abiotic and biotic stresses, and with better quality are needed.
- Suitable interventions at the farm level including intercropping of vegetables with sugarcane, honey bees for pollination and higher yield / income in crops like mustard, sunflower and others can also lead to enhanced income.
- Farmers need to be provided with custom hiring services and post-harvest management of produce for value addition.
- Improved breeds of cattle and buffalo are needed for a lactation period of 9-11 months by artificial insemination, reducing puberty and detecting pregnancy. Further, improved fodder availability and value addition with ammonia treatment will help in improving productivity and profitability.
- Transfer of technology needs to utilize recent innovations in IT through the vast network of KVKs for quick dissemination of information and input availability.
- Youth need to be attracted towards farming by resorting to mechanization, skill development and income generation.
- Liking farmers with market especially with super markets as in China is needed.
- Losses of perishable produce need to be reduced by cold chain arrangement, market intelligence and processing. Innovative food processing models need to be replicated.
- Enterprise diversification should take into consideration high-value crops, horticulture, honey bees, animal husbandry and market.
- Integrated farming systems approach should be based on *in situ* generation of resources and their inter-dependence. Successful models of IFS based on dairy and organic farming, such as the one developed by a farmer in Andhra Pradesh and at CSSRI, Karnal are needed.
- Irrigation potential needs to be created with better utilization efficiency of

available water through precise and pressurized irrigation systems like sprinkler and drip irrigation.

- Timely and easily availability of credit support and inputs will help in improving productivity and profitability. Socio-economic aspects of technology development and dissemination should be duly addressed.
- Rainwater harvesting needs greater emphasis in rainfed areas, which should help in diversification and sustainable production.

Glimpses of Fourth International Agronomy Congress


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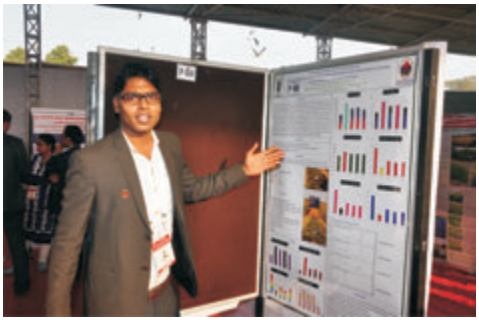


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TECHNICAL PROGRAMME

Fourth International Agronomy Congress
Agronomy for Sustainable Management of Natural Resources, Environment, Energy and Livelihood Security to Achieve Zero Hunger Challenge

22–26 November 2016, New Delhi, India
Venue: Exhibition Ground, IARI, New Delhi

Day 1: November 22, 2016

9:30–11:30	**Inaugural Session (Hall-1)**
12:00–13:00	**Presidential address**
Co-chairs:	**Dr M.S. Swaminathan**, MSSRF, Chennai, India **Dr R.S. Paroda**, TAAS, New Delhi, India
Speaker:	**Dr Gurbachan Singh**, ASRB, New Delhi, India *Agronomy for sustainable management of natural resources*
14:00–17:30	**CONCURRENT SYMPOSIA (I, II, III) and SPECIAL SESSION I**
	Symposium I: Climate Smart Agronomy (Hall – 1)
Co-chairs:	**Dr J.S. Samra**, Formerly NRAA, New Delhi, India **Dr P.K. Aggarwal**, CCAFS, CIMMYT-BISA, New Delhi, India
Convener:	**Dr M.L. Jat**, CIMMYT, New Delhi, India
Keynote Speaker:	**Dr Clare M. Stirling**, CIMMYT, UK *Climate change and greenhouse gases mitigation from agriculture: Where are the big wins?*
Lead Speakers:	**Dr Thomas Wegmann**, Asia-Pacific Bayer Crop Science, Innrain, Germany *Shaping the future of farming* **Dr Vincent Vadez**, ICRISAT, Hyderabad, India *Understanding crop physiological processes for climate resilience* **Dr Alison Laing**, CSIRO, Brisbane, Australia *Cropping system modelling in South Asia: managing production risks under current and future climates* **Dr Annemarie Groot**, Wageningen University and Research, Wageningen, The Netherlands *Climate smart agriculture practices led business cases: Some examples* **Dr S. Pasupalak**, OUAT, Bhubaneswar, India *Climatic vulnerabilities in Indian agriculture: Adaptation and mitigation strategies*

	Dr S.K. Chaudhari, ICAR, New Delhi, India *Resilient agronomic management: options and learning's through NICRA Experiences*
Rapid Fire Presentations:	**Dr G. Ravindra Chary**, ICAR–CRIDA, Hyderabad, India *Climate resilient agronomic innovations for rainfed farming in sub–tropics* **Dr Tek B. Sapkota**, CIMMYT, New Delhi, India *Adaptation led mitigation in Indian agriculture* **Dr Paresh B. Shirsath**, CCAFS–South Asia, New Delhi, India *Prioritizing CSA land use options at a regional scale* **Dr Devraj Arya**, RML, Pune, India *ICTs and digital services for scaling climate smart agriculture* **Dr S.K. Datta**, IPNI-South Asia Programme, Kolkata, India *Nutrient management for wheat system intensification, food security and environmental sustenance*
14:00–17:30	**Symposium II: Organic Agriculture (Hall – 2)**
Co-chairs:	**Dr R.B. Singh**, Formerly NAAS, President, New Delhi, India **Dr S.C. Modgal,** GBPUAT, Pantnagar, India
Convener:	**Dr R.K. Avasthe,** ICAR-NOFRI, Gangtok, India
Keynote Speaker:	**Dr A.K. Yadav**, APEDA & NCOF, New Delhi, India *Organic farming in 21st century*
Lead Speakers:	**Dr B.P. Bhatt,** ICAR-RCER, Patna, India *Prospects of organic farming in small holder systems* **Dr B.S. Mahapatra**, GBPUAT, Pantnagar, India *Organic agriculture technology and sustainability* **Dr R.K. Avasthe,** ICAR-NOFRI, Gangtok, India *Sikkim's organic journey*
Rapid Fire Presentations:	**Dr N. Ravisankar**, ICAR–IIFSR, Modipuram, India *Organic and towards organic agriculture in India for safe and secured food* **Dr Dinesh Kumar**, ICAR–IARI, New Delhi, India *Soil fertility, productivity and profitability of organic rice–based cropping systems* **Dr Mahesh Chander**, ICAR–IVRI, Izatnagar, India *Enhancing sustainability in organic farming* **Dr Anup Das**, ICAR Research Complex for NEH Region, Barapani, India *Organic farming in north-eastern hills: Innovation for sustainability and livelihood*
14:00–17:30	**Symposium III: Agriculture Diversification for Sustainable Resources (Hall – 3)**
Co-chairs:	**Dr David Bergvinson**, ICRISAT, Hyderabad, India

	Dr P.K.R. Nair, University of Florida, Gainesville, USA
Convener:	**Dr D.P. Biradar**, UAS, Dharwad, India
Keynote Speaker:	**Dr P.K.R. Nair**, University of Florida, USA *Agrodiversity and ecosystem sustainability*
Lead Speakers:	**Dr Rao Mentreddy**, Alabama A&M University, USA *The importance of agronomic practices on essential composition of aromatic crops* **Dr D.P. Biradar**, UAS, Dharwad, India *Agricultural diversity and ecosystem sustainability* **Dr Andrew McDonald**, CIMMYT, Kathmandu, Nepal *Possibilities, pre-conditions and pathways for achieving crop diversification in South Asia* **Dr N.P. Singh**, ICAR-NIASM, Baramati, India *Improving farmers prosperity in coastal ecosystems of India through integrated farming system* **Dr P.K. Ghosh**, ICAR–IGFRI, Jhansi, India *Sustainable intensification and diversification: Means for maintaining soil health* **Dr E.V.S. Prakasa Rao**, Formerly CSIR–CMMCS, Bengaluru, India *Ecological services and economic benefits of aromatic crops*
Rapid Fire Presentations:	**Dr H.S. Jat**, CIMMYT, Karnal, India *Sustainable intensification of cereal–based systems in western IGP: Scalable evidence* **Dr Anil K. Choudhary**, ICAR–IARI, New Delhi, India *Crop diversification options to enhance farm productivity and rural livelihoods innorth–western Himalayas* **Dr Rajendra Hegde**, ICAR–NBSSLUP, Bengaluru, India *Site-specific land resources inventory for science-based crop diversification and crop production enhancement* **Dr Sangu Angadi**, New Mexico State University, USA *Spatial arrangement and crop combination effect on sorghum and intercrops productivity in forage production system*
14:00–17:30	**Special Session I: Youth and Agriculture: Challenges and Opportunities (WTC Auditorium, IARI)**
Co-chairs:	**Dr R.S. Paroda**, TAAS, New Delhi, India **Dr A.K. Srivastava,** NDRI, Karnal, India
Convener:	**Dr Y.S. Saharawat**, ICARDA, Kabul, Afghanistan
Lead speakers:	**Dr Jim Kano**, YPARD, Philippines *Youth and agriculture: Asia-Pacific perspective*

Dr P. Adhiguru
Attaining and retaining youth in agriculture: ICAR initiative and success stories
Dr Nikki Pilani Chaudhary
Agroforestry and dairy farm: An innovative model for attracting youth inagriculture
Dr Yiewi Dong
Youth and agriculture: China perspective
Dr Satendra Singh Arya
Agriculture Sector Skill Council of India: Perspective of skill developmentprograms in India
Dr Kushagra Srivastava
A journey from IIT graduate to agripreneurs
Dr Sridhar Gutam
Ten years of YPARD in India
Dr Rikin Gandhi
Youth innovation in technology transfer to farmers

Panel Discussion

Moderator: **Mr Ajay Vir Jakhar**, New Delhi, India

Panelists: **Mr Vikas Choudhary**, Young Farmer, Karnal, India

Mr Sudhir Kumar, All India Agricultural Students Association, New Delhi, India

Mr Misha Madhvan M., NDRI, Karnal, India

Ms Nikita Bhusal, Kathmandu, Nepal

Dr Devraj Arya, RML, Pune, India

17:30–18:30 **Evening Lecture – 1 (Hall-1)**

Co-chairs: **Dr V.L. Chopra**, Formerly Planning Commission, Govt. of India, New Delhi, India

Dr V.M. Katoch, Ex-DG, ICMR, Govt. of India, New Delhi, India

Speaker: **Dr M.S. Swaminathan**, MSSRF, Chennai, India
Breeding and feeding for high yields in food crops

Day 2: November 23, 2016

9:30–11:30 **Plenary lectures 1 and 2 (Hall-1)**

Co-chairs: **Dr M.S. Swaminathan**, MSSRF, Chennai, India

Dr Y.K. Alagh, Central University, Gandhinagar, India

Speakers: **Dr Matthew Morrel,** IRRI, Manila, Philippines
Rice-based systems research and meeting the sustainable development goals

Dr Trilochan Mohapatra, ICAR, New Delhi, India
Climate resilience and sustainability of Indian agriculture: Challenges and opportunities

11:30–15:30	**CONCURRENT SYMPOSIA (IV, V and VI) and SPECIAL SESSION II**
	Symposium IV: Integrated Farming Systems for Smallholder Farmers (Hall-1)
Co-chairs:	**Dr John Dixon**, ACIAR, Canberra, Australia **Dr Javed Rizvi**, ICRAF, New Delhi, India
Convener:	**Dr A.S. Panwar**, ICAR-IIFSR, Modipuram, India
Keynote Speaker:	**Dr Santiago Lopez Ridaura**, CIMMYT, Mexico *Future farming systems and farm design*
Lead Speakers:	**Dr A.K. Singh**, BAU, Sabour, India *Integrated farming systems for augmenting income of small and marginal farmholdings in Eastern India* **Dr S. Bhaskar**, ICAR, New Delhi, India *Integrated farming systems for improving livelihood of under-privileged farmers* **Dr B. Gangwar**, Formerly ICAR–IIFSR, Modipuram, India *Farming system approaches for income and employment enhancement of under-privileged farm households* **Dr C. Jayanthi**, TNAU, Coimbatore, India *Development and practicing of successful crop-based farming systems for under-privileged farmers* **Dr M.S. Gill**, Formerly PAU, Ludhiana, India *Family farming systems: Approach towards self–reliance* **Dr D.K. Sharma**, ICAR–CSSRI, Karnal, India *Diversified farming systems for sustainable livelihood security of small farmers in salt-affected areas of Indo–Gangetic plains* **Dr U.K. Behera**, ICAR–IARI, New Delhi, India *Energy self-sufficient sustainable integrated farming systems for livelihood security under changing climate scenario*
Rapid Fire Presentations	**Dr R.V. Bhavani**, MSSRF, Chennai, India *A farming system approach to address under–nutrition* **Dr Anis Chaterjee**, AFFP, New Delhi, India *Integrated farming systems for the under-privileged farmers of north-east* **Dr Dileep Kachroo**, SKAUST, Jammu, India *Conceptual approach for profitable farming systems of small and marginal farmers of Western Himalayan hills* **Dr Narendra Prakash**, ICAR Research Complex for NEH, Imphal, India *Impact of integrated farming system on farmers livelihood and nutritional security as well as family employment*
11:30–15:30	**Symposium V: Abiotic and Biotic (Weeds) Stress Management (Hall-2)**
Co-chairs:	**Dr R.S. Paroda**, TAAS, New Delhi, India **Dr Kadambot Siddique**, UWA, Perth, Australia

Convener: **Dr Ch. Srinivas Rao**, ICAR–CRIDA, Hyderabad, India

Keynote Speakers: **Dr Anthony Whitbread**, ICRISAT, Hyderabad, India
Managing climate variability and change: can lessons from large scale commercial farming in Australia help the smallholder farmer in semi–arid India?
Dr Kadambot Siddique, UWA, Perth, Australia
The role of conservation agriculture in rainfed environments

Lead Speakers: **Dr B.M. Prasanna**, CIMMYT, Nairobi, Kenya
Developing and deploying climate–resilient maize varieties: a global perspective
Dr Bhagirath Singh Chauhan, University of Queensland, Australia
Research needs to improve weed management in direct–seeded rice
Dr Ch. Srinivas Rao, ICAR–CRIDA, Hyderabad, India
Agriculture contingency plans towards adaptation of Indian agriculture underclimate change impacts
Dr P.C. Sharma, ICAR–CSSRI, Karnal, India
Sustaining crop productivity during post-reclamation phase following resource conservation technologies in reclaimed sodic soils

Rapid Fire Presentations: **Dr Yassen Khalil**, University of Western Australia, Crawley, Australia
The effect of rainfall amount and intensity on leaching of herbicides from stubble
Dr Rexa Aghnoum, AREEO, Mashhad, Iran
Effect of sowing date on barley yellow dwarf virus (BYDV) severity in different wheat cultivars
Dr S.K. Choudhary, Agriculture and Forestry University, Rampur, Nepal
Sesbania brown manuring on weeds infestation and performance of DSR as compared to farmers' practice and chemical control method
Dr M.M. Rahman, BAU, Mymenshing, Bangladesh
Residual effect of herbicides applied to wheat on the establishment of succeeding crops
Dr Sumanta Kundu, ICAR–CRIDA, Hyderabad, India
Increasing the possibility of double cropping by mitigating water and nutrient stress through conservation agriculture in rainfed Alfisols
Dr V.K. Choudhury, ICAR–NIBSM, Raipur, India
Biotic stresses in crops with special reference to weed management

11:30–15:30 **Symposium VI: Efficient Soil, Water and Energy Management (Hall-3)**

Co-chairs: **Dr I.P. Abrol**, CASA, New Delhi, India
Dr J.C. Katyal, Formerly CCS HAU, Hisar, India

Convener:	**Dr B.S. Dwivedi**, ICAR-IARI, New Delhi
Keynote Speaker:	**Dr A.C. Tyagi**, ICID, New Delhi, India Is water security going to be crucial for the zero hunger challenge?
Lead Speakers:	**Dr A.K. Sikka**, IWMI, New Delhi, India *Managing water and energy for sustainable agriculture* **Dr Ajit K. Sarmah**, The University of Auckland, New Zealand *Smart soils and agricultural resiliency: A perspective* **Dr Ravindra Kaur**, ICAR–IARI, New Delhi, India *Innovation in waste water management* **Dr Phil Ward**, CSIRO, Australia *Diversity of rotation, rather than residue retention, affects wheat yield and water-use efficiency under dryland conservation agriculture* **Dr V. Praveen Rao**, PJTSAU, Hyderabad, India *Water–smart production for ensuring food and nutritional security*
Rapid Fire Presentations:	**Dr Santanu Mukherjee**, Institute für Bio– und Geowissenschaften, Jülich, Germany *Mitigation of point source pollution of water: Steps towards addressing water security* **Dr Ramanjeet Singh**, ICAR–IISWCR, Dehradun, India *Energy synthesis in crop production* **Dr A.V. Ramanjaneyulu**, RARS, Palem, India *Role of farm ponds in enhancing the livelihoods of rainfed farmers –A case study* **Mr Lalit Kumar Rolaniya**, PAU–CIMMYT–BISA, Ludhiana, India *Precision water management in conservation agriculture based cereal systems* **Dr Khajanchi Lal**, WTC, ICAR-IARI, New Delhi, India *Biodrainage for reducing the salinity* **Dr Avil Kumar Kodary**, PJTSAU, Hyderabad, India *Drip irrigation influence on yield and water productivity of rabi sorghum*
11:30–15:30	**Special Session II: Big Data and Evidence–based Agronomy (WTC Auditorium, IARI)**
Co-chairs:	**Dr Patrick C. Wall**, CIMMYT, Mexico **Dr Rajender Parsad**, ICAR-IASRI, New Delhi, India
Conveners:	**Dr Kaushik Majumdar**, IPNI, Gurugram, India **Dr M.L. Jat**, CIMMYT, India
Lead Speakers:	**Dr Paul E. Fixen**, American Society of Agronomy, USA *Evidence-based agronomy for sustainable food security* **Dr Sylvie Brouder**, Purdue University, USA *Data management planning for extended data life cycles*

Dr J.K. Ladha, IRRI, Manila, Philippines
Integrating the findings of multiple individual studies to make generic conclusions - Some examples
Dr Steven B. Phillips, IPNI, USA
How precision agriculture technologies can facilitate citizen science

16:00–17:00 **Poster evaluation (P1 to P250)**

17:00–18:00 **Evening Lecture –2 (Hall-1)**

Co-chairs: **Dr Paul E. Fixen**, American Society of Agronomy, USA
Dr Trilochan Mohapatra, ICAR, New Delhi, India

Speaker: **Dr R.S. Paroda**, TAAS, New Delhi, India
Scaling innovations in natural resource management for sustainable agriculture

Day 3: November 24, 2016

9:30–11:00 **Plenary lectures 3 and 4 (Hall-1)**

Co-chairs: **Dr R.S. Paroda**, TAAS, New Delhi, India
Mr Ashish Bahuguna, FSSAI, New Delhi, India

Speakers: **Dr David Bergvinson**, ICRISAT, Hyderabad, India
Sustainable management of natural resources for improving rural livelihoods andnutritional security
Dr R.B. Singh, Formerly NAAS, New Delhi, India
Towards a zero hunger India

11:30–15:30 **CONCURRENT SYMPOSIA (VII, VIII, IX) and SPECIAL SESSION III**

Symposium VII: Precision Nutrient Management (Hall-1)

Co-chairs: **Dr Paul E. Fixen**, American Society of Agronomy, USA
Dr A.K. Sikka, IWMI, New Delhi, India

Convener: **Dr Kaushik Majumdar**, IPNI, Gurugram, India

Keynote Speaker: **Dr Steven B. Phillips**, IPNI, USA
Advances in precision nutrient management: Global scenario

Lead Speakers: **Dr M.L. Jat**, CIMMYT, New Delhi, India
Precision nutrient management in conservation agriculture systems
Dr Francelino A. Rodrigues, CIMMYT, Mexico
Recent advancements in application of UAVs and remote sensing for precision nutrient management
Dr T. Satyanarayana, IPNI–South Asia Program, Gurugram, India
Site–specific nutrient management in smallholder systems of Asia using a novel decision support tool
Dr B.S. Dwivedi, ICAR–IARI, New Delhi, India
Advances in precision nutrient management: Indian scenario

	Dr V.K. Singh, ICAR–IARI, New Delhi, India *Precision nutrient management for predominant cropping systems of India*
Rapid Fire Presentations:	**Dr Hirak Banerjee**, BCKV, Kalyani, India *Farm typology based nutrient management for maize intensification* **Dr Priyabrata Santra**, ICAR–CAZRI, Jodhpur, India *Mapping soil nutrient status and evaluating its accuracy and uncertainty for precision management* **Dr Gopal Ramdas Mahajan**, ICAR–CCARI, Goa, India *Newer and Innovative tools for making soil test based fertilizer recommendationsto crops* **Dr R. Mahender Kumar**, ICAR–IIRR, Hyderabad, India *Precision nutrient management in rice systems of India* **Dr Thomas Ogon Ojikpong**, Cross River University of Technology, Obubra, Nigeria *The effects of moringa leaves and nitrogen, phosphorus and potassium(15:15:15) fertilizer on the yield and protein content of soybean in Obubra, south eastern Nigeria* **Dr Shankar Lal Jat**, ICAR–IIMR, New Delhi, India *Precision nutrient management in maize-based systems*
11:30–15:30	**Symposium VIII: Conservation Agriculture and Smart Mechanization (Hall-2)**
Co-chairs:	**Dr J.K. Ladha**, IRRI, Manila, Philippines **Dr A.R. Sharma**, ICAR-DWR, Jabalpur, India
Convener:	**Dr Y.S. Saharawat**, ICARDA, Kabul, Afghanistan
Keynote Speakers:	**Dr Amir Kassam**, FAO, Rome, Italy *Conservation agriculture for sustainable intensification: Global options and opportunities* **Dr Patrick C. Wall,** CIMMYT, Mexico *Conservation agriculture: Lessons and opportunities in Africa and Latin America*
Lead Speakers:	**Dr H.S. Sidhu**, CIMMYT-BISA, Ludhiana, India *Mechanization: A need for sustainable intensification* **Dr A.R. Sharma**, ICAR–DWR, Jabalpur, India *Adoption of conservation agriculture technologies in non–IGP, of India* **Dr T.K. Das**, ICAR–IARI, New Delhi, India *Conservation agriculture in cereal systems: an Indian experience* **Dr Mahesh K. Gathala**, CIMMYT, Dhaka, Bangladesh *Conservation agriculture based smallholder systems in Eastern IGP of South Asia*
Rapid Fire Presentations:	**Dr C.M. Parihar**, ICAR–IIMR, New Delhi, India *Long-term conservation agriculture in maize-based cropping systems under semi–arid agroecosystem*

	Dr Naveen Patidar, Agha Khan Foundation, India *Conservation agriculture: A case study through eyes of developmental organization* **Dr Virender Kumar**, IRRI, Manila, Philippines *Weed dynamics in conservation agriculture based cropping systems* **Dr Raj Kumar Jat**, CIMMYT-BISA, Samastipur, India *Conservation agriculture: options and opportunities in eastern IGP*
11:30–15:30	**Symposium IX: Innovation Systems and Last Mile Delivery (Hall-3)**
Co-chairs:	**Dr Clare M. Stirling**, CIMMYT, U.K. **Dr A.K. Singh**, ICAR, New Delhi, India
Convener:	**Dr S. Bhaskar**, ICAR, New Delhi, India
Keynote Speaker:	**Dr Michael Misiko**, CIMMYT, Kenya *Models of scaling agronomic benefits among resource-poor farmers -Experiences from Africa*
Lead Speakers:	**Dr R. Parshad**, ICAR, New Delhi, India *A fresh look to agricultural innovations capacity development for extended reach* **Dr R.K. Malik**, CIMMYT, Patna, India *Sustainable intensification of rice–wheat cropping system: Challenges and approaches for evolution and delivery* **Dr J.P. Sharma**, ICAR–IARI, New Delhi, India *Upscaling and out-scaling of farmer-led innovations for sustainability and maximizing farmer's profitability* **Dr Randhir Singh**, ICAR, New Delhi, India *Innovations in knowledge sharing and technology application* **Dr N. Nagaraja**, UAS, Bengaluru, India *Innovative approaches for effective last mile delivery of agricultural technologies*
Rapid Fire Presentations:	**Dr P.J. Van Erp**, Soil Cares Research Nieuwe Kanaal, Wageningen, The Netherlands *Mobile soil testing using proximal sensor technology are key to contributing to last–mile delivery problems on soil nutrient management* **Dr Syed Shakir Ali**, KVK, Baramati, India *Innovation in the extension methodology for reaching to unreached*
11:30–15:30	**Special Session III: Sustainable Intensification with Particular Reference to Scaling Science (WTC Auditorium, IARI)**
Co-chairs:	**Dr John Dixon**, ACIAR, Canberra, Australia **Dr Li Lingling**, China
Convener:	**Dr Mahesh K. Gathala**, CIMMYT, Dhaka, Bangladesh
Keynote Speaker:	**Dr John Dixon**, ACIAR, Canberra, Australia *Framing sustainable intensification for widespread scaling*

Lead Speakers:	**Dr Mulugetta Mekuria**, CIMMYT, Harare, Zimbabwe *Achievements and lessons from Africa sustainable intensification of maizelegume and forage systems in rainfed agriculture* **Dr T.P. Tiwari / Dr M. Gathala**, SRFSI, Bangladesh *Innovation platforms and micro–entrepreneurship for scaling conservation agriculture based sustainable intensification in the eastern Gangetic Plains* **Prof Li Lingling**, China *Reviving sustainable intensification from long-term conservation trials in lowrainfall environments* **Prof Danial Tan**, Cambodia *Challenges of transitioning from sustainable intensification to sustainable diversification in N W Cambodia* **Dr Tamara Jackson**, Lao PDR *Innovation systems and adoption experiences: the story of mechanised dry direct seeding in outhern Lao PDR*
16:00–17:00	**Poster Evaluation (P251 to P500)**
17:30–18:30	**Evening Lecture – 3 (Hall-1)**
Co-chairs:	**Dr Matthew Morell**, IRRI, Manila, Philippines **Dr R.B. Singh**, Formerly NAAS, New Delhi, India
Speaker:	**Dr John Dixon**, ACIAR, Canberra, Australia *The future of sustainable intensification and diversification for different rural environments*
18:30–20:00	**General Body Meeting, ISA (Hall-1)**

Day 4: November 24, 2016

9:30–11:00	**Plenary lectures 5 and 6 (Hall-1)**
Co-chair:	**Mr P.K. Basu**, Formerly DAC FAO, New Delhi, India
Speakers:	**Dr Panjab Singh**, FAARD, Varanasi, India *Climate change and food security challenges and our preparedness* **Dr K.L. Chadha**, Horticultural Society of India, New Delhi, India *Agricultural diversification through horticultural crops for nutritional security*
11:30–15:30	**CONCURRENT SESSIONS (X, XI, XII) and Special Session IV** **Symposium X: Livelihood Security and Farmers Prosperity (Hall-1)**
Co-chairs:	**Dr. Ramesh Chand**, NITI Ayog, New Delhi, India **Dr P.K. Joshi**, IFPRI, New Delhi, India
Convener:	**Dr Suresh Pal**, ICAR-NIAP, New Delhi, India
Keynote Speakers:	**Dr Jitendra Srivastava,** World Bank, Washington, USA *Putting pieces together for boosting livelihood security and prosperity of ruracommunities*

Lead Speakers:	**Dr P.S. Birthal**, ICAR-NIAP, New Delhi, India *Agricultural diversification for farmers prosperity* **Dr R.S. Sidhu**, PAU, Ludhiana, India *Enhancing farmers prosperity in the irrigated agriculture* **Dr P. Das**, Formerly ICAR, New Delhi, India *Technology innovation process and methodology for the last mile delivery of agronomic management practices* **Dr K.D. Kokate**, MPKV, Rahuri, India *Timely and valid agronomic technology management information to all stakeholders for climate smart agriculture: An experience* **Dr Prasanth Goswami**, CSIR–NISTADS, New Delhi, India *Sustainable agronomical and agricultural trade policies for India* **Dr Surabhi Mittal**, Tata–Cornell Institute for Nutrition, New Delhi, India *ICTs for linking science with society for Improving income and livelihoods*
Rapid Fire Presentations:	**Dr N.P. Singh**, ICAR–NIAP, New Delhi, India *Vulnerability of agriculture to climate change: policy imperatives* **Dr Shalander Kumar**, ICRISAT, Hyderabad, India *Livelihood security and farmers prosperity in SAT agriculture* **Dr G.K. Jha**, ICAR–IARI, New Delhi, India *Energy use and crop productivity in agriculture*
11:30–15:30	**Symposium XI: Emerging Challenges for Agronomic Education (Hall-2)**
Co-chairs:	**Dr Panjab Singh**, FAARD, Varanasi, India **Dr Arvind Kumar**, RLB CAU, Jhansi, India
Convener:	**Dr M.B. Chetti**, ICAR, New Delhi, India
Keynote Speakers:	**Dr S.C. Modgal**, Formerly GBPUAT, Pantnagar, India *Changing phase of agronomy education* **Dr Arvind Kumar**, RLB CAU, Jhansi, India *New vistas in agronomic education* **Dr Ramesh Kanwar**, Lovely Professional University, Jalandhar, India *Privatization of agronomy education for professionalism*
Lead Speakers:	**Dr N.S. Rathore**, ICAR, New Delhi, India *Innovations in agronomic education* **Dr D.P. Singh**, Formerly JNKVV, Jabalpur, India *Agronomy towards management of natural resources, food security and environment sustainability* **Dr N.T. Yaduraju**, Formerly ICAR–DWR, Jabalpur, India *Challenges and opportunities in weed science research and education* **Dr T.K. Prabhakarasetty**, UAS, Bengaluru, India *New dimensions in agronomic research for food security*

	Dr Anupam Varma, ICAR-IARI, New Delhi, India *Emerging challenges of education for agronomic research*
	Dr R.M. Kathiresan, Annamalai University, Annamalai, India *Need for curriculum reinforcement with allied and applied sciences for gender parity in agronomy education and research*
	Dr A.K. Vyas, ICAR, New Delhi, India *Capacity building and competency enhancement for addressing challenges of agronomic research and education in India*
Rapid Fire Presentations:	**Dr P.S. Bodake**, ZARS, Igatpuri, India *Future agronomic research for market and climate oriented needs*
	Dr Nitin Gudadhe, Gujarat, India *Reorienting agronomy education and research*
	Dr A.K. Tripathi, Kanpur, India *Redefining agronomy and its pertinence in context to current agricultural education*
11:30–15:30	**Symposium XII: New Paradigms in Agronomic Research (WTC Auditorium)**
Co-chairs:	**Dr M.C. Saxena,** Formerly ICARDA, Jordan, Syria
	Dr E.V.S. Prakasa Rao, Formerly CSIR–CMMCS, Bengaluru, India
Convener:	**Dr A.R. Sharma**, ICAR–DWR, Jabalpur, India
Keynote Speaker:	**Dr M.C. Saxena**, Formerly ICARDA, Jordan, Syria *Preparing agronomists for meeting research challenge for producing more from less for more*
Rapid Fire Presentations	**Dr Bhupender Kumar**, ICAR–IIMR, New Delhi, India *AMMI analysis to identify maize hybrids adapted under drought stress and normal ecologies in tropical climate*
	Dr C. Chinnusamy, TNAU, Coimbatore, India *Long-term tillage and weed management methods in maize–sunflower cropping system under irrigated ecosystem*
	Dr Chandra Gupta, IISR, Lucknow *Integrated nutrient management on growth and yield of sugarcane*
	Dr Dibakar Mahanta, ICAR–VPKAS, Almora, India *Zero tillage reduces soil and nutrient losses and improves soil quality compared to conventional tillage*
	Dr G.A. Shitu, ICAR–IARI, New Delhi, India *Is precision conservation agriculture a way to achieve second green revolution in India?*
	Dr Kapila Shekhawat, ICAR–IARI, New Delhi, India *Nitrogen and weed management in conservation agriculture based maize–wheat cropping system*
	Dr Monika Kundu, ICAR–IARI, New Delhi, India *Wheat shoot bending characteristics: A technology to determine the lodgingtendency*

Dr Nisha Kant Chopra, ICAR–IARI Regional Station, Karnal, India
Improving the quality of farmers saved seed through seed village programme

Dr O.T. Owolabi, Ekiti State University, Nigeria
Can Africa achieve food sufficiency? Taking lessons from Indian agriculture in the face of 21st century agricultural challenges

Dr P. Murugan, TNVASU, Kattupakkam, India
Evolving profitable integrated farming system model for irrigated upland of Kancheepuram district of Tamil Nadu

Dr P. Saravanane, PJNCOARI, Karaikal, India
Effect of weed competition and establishment methods in direct-seeded rice

Dr Parvender Sheoran, ICAR–CSSRI, Karnal, India
Impact of salinity on physiological and biochemical traits in pearlmillet

Dr Pheng Sengxua, NAFRI, Vientiane, Lao PDR
Management of sweet corn for multiple purposes in southern Lao PDR

Dr Ramanjit Kaur, ICAR–IARI, New Delhi, India
Promising genotypes of maize suitable for varying irrigation regimes and fertilizer management in maize–wheat cropping system

Dr S.O. Toluwase, Ekiti State University, Nigeria
Resource-use efficiency in yam production in Eiti State, Nigeria

Dr Sher Singh, ICAR–VPKAS, Almora, India
Weed wiper – A tool for drudgery reduction and resource conservation

Dr Sheraj Mahdi, BAU, Sabour, India
Temperature extremes: Impact on wheat over a sub–humid climatic environment of Bihar, India: A simulation study

Dr Shiva Dhar, ICAR–IARI, New, India
Productivity of wheat under preceding legumes and cereals with organic and inorganic nutrition

Dr Ummed Singh, ICAR–IIPR, Kanpur, India
Mechanical harvesting of pulses : Future perspectives

Dr Jasvir Singh Gill, PAU, Ludhiana, India
Design, development and evaluation of lucky seed drill for simultaneous seeding and spraying of pre–emergence herbicides

Dr C.S. Praharaj, ICAR-IIPR, RS, Bhopal, India
Sustaining soybean in central India through intercropping and rotation with pulses

11:30–15:30	**Special Session IV: Scaling Agronomic Innovations in Cereal–based**
Co-chairs:	**Dr R.S. Paroda**, TAAS, New Delhi, India
	Dr J.C. Katyal, Formerly CCSHAU, Hisar, India
Convener:	**Dr Y.S. Saharawat**, ICARDA, Kabul, Afghanistan
Keynote Speaker:	**Dr María Beatriz (Pilu) Giraudo,** Edificio Dorrego Bureaux, Argentina *Modern agriculture based on no-till systems to meet human demands*
Lead speakers:	**Dr Amir Kassam**, FAO, Rome, Italy *Integrated innovative production technologies in cereal systems: Global perspective*
	Dr M.L. Jat, CIMMYT, New Delhi, India *Conservation agriculture: A way forward for sustainable intensification in south Asia*
	Dr Anil Kumar Verma, PRAN, Gaya, India *System of rice intensification: An innovation in rice production system*
	Dr Kaushik Majumdar, IPNI, Gurugram, India *Innovations in nutrient management for efficient cereal production systems in south Asia*
Panel Discussion:	**Dr B.S. Sidhu**, Govt of Punjab, Chandigarh, India
	Dr R.K. Malik, CIMMYT, Patna, India
	Dr Rajbir Singh, ICAR-ATARI, Ludhiana, India
	Mr Vikas Choudhary, Farmer, Haryana, India
	Mr Tinni Sawhney, CEO, Agha Khan Foundation, India
	Dr R. Mahender Kumar, ICAR–IIRR, Hyderabad, India
16:00–17:00	**Poster evaluation (P501 to P750)**
17:00–18:00	**Evening Lecture – 4 (Hall-1)**
Co-chairs:	**Dr David Bergvinson**, ICRISAT, Hyderabad, India
	Dr Panjab Singh, FAARD, Varanasi, India
Speaker:	**Dr Paul E. Fixen**, American Society of Agronomy, USA *Making waves ... Einstein's lessons for Agronomy*

Day 5: November 26, 2016

9:30–11:00	**Plenary lectures 7 and 8 (B.P. Pal Auditorium, IARI)**
Co-chairs:	**Mr Shobhana K. Pattanayak**, DACFW, New Delhi, India
	Dr K.L. Chadha, Horticultural Society of India, New Delhi, India
Speakers:	**Dr Ramesh Chand**, NITI Ayog, New Delhi, India *Dietary diversification and nutrition*

	Dr J.S. Samra, Formerly NRAA, New Delhi, India *Nexus among poverty, hunger, water and energy in India*
11:30–13:00	**Panel Discussion on 'Doubling farmers income' (B.P. Pal Auditorium, IARI)**
Moderators:	**Dr Gurbachan Singh,** ISA, New Delhi, India
	Dr M.L. Jat, CIMMYT, New Delhi, India
Penalists:	**Dr J.S. Sandhu**, ICAR, New Delhi, India
	Dr A.K. Singh, ICAR, New Delhi, India
	Dr A.K. Srivastava, ICAR-NDRI, Karnal, India
	Dr S. Bhaskar, ICAR, New Delhi, India
	Dr P.S. Rathore, SKNAU, Jobner, India
	Dr S.K. Malhotra, New Delhi, India
	Mr Satish Babu, Farmer, Andhra Pradesh, India
	Mr Kanwal Singh Chauhan, Farmer, Haryana , India
13:00–14:00	**Closing Ceremony**