NAAS NEWS

RESEARCH EDUCATION AND TECHNOLOGY POLICY FORUM

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From the President's Desk

Innovations for Agricultural Transformation

The NAAS in collaboration with the ICAR and IARI will be organizing XIV Agricultural Science Congress at New Delhi from February 20-23, 2019 on the theme "Innovations in Agricultural Transformation". The theme of the Congress is central to the national complementary pledges of building a New India and Doubling Farmers' Income by 2022. The New India must be free from hunger, malnutrition, poverty, and glaring inequalities.

"Innovation is the process by which inventions are produced – it may involve new ideas, new technologies, or novel applications of existing technologies, new processes or institutions, or more generally, new ways of doing things in a place or by people where they have not been used before" (Juma *et al.* 2013). Innovation, thus, has to be viewed in a broader context – multidisciplinary and multi-stakeholder system geared to enhance productivity, income of the farmers, inclusiveness, livelihood security, input-use efficiency, climate resilience and ecological/environmental sustainability. Thus, agricultural innovation is a *sine qua non* for meeting the Sustainable Development Goals (SDGs).

The development of agricultural innovation system is closely related to agricultural production and rural economy. In fact, innovation has been the main driver of the Green Revolution in India, an unprecedented success of transforming a food-deficit country into a food-surplus one, rendering India as the second largest agricultural economy in the world. It was the orchestration of technology, input support, farmer-market linkage, farmers' enthusiasm, political will, and international technical cooperation, which created and nurtured the Green Revolution.

Despite the dramatic progress in productivity, production, and food and livelihood security, India is still home to one-fourth of the world's hungry and more than one-third of the world's stunted and wasted children. Our agricultural innovation system should thus be responsive to a market-based agriculture and rural economy, advancement of agricultural production structure in face of surplus in traditional agricultural outputs, stagnation in income of farmers, lamentable state of unemployment of rural population, wastage of valuable natural resources & their degradation and environmental deterioration.

In view of the above, there is a strong need to bring transformation of the agriculture sector through innovations. One approach of innovation is to make adjustments of

agricultural production systems for development of large agri-businesses whose production rests on large scale of operation with high efficiency. The reform on contracted use of land property permits transactions of land use rights that made it possible for such enterprises to grow, as long as farmers could find out assured employment opportunities after having sold out their land rights. Another approach might be more feasible, based on small-scale production of farmers who don't have to lose their land. It may be called consortium or co-operatives of small and marginal farmers' base. This base will play different roles of providing materials and technology support, breeder seeds, other materials supplier, technology instructor, and disposal of output from plantation. Thus, risks in technology and market that farmers face are reduced, and costs for maintaining quality supply of agricultural products are lowered to some extent.

The farmers' bases could be organized in different ways. In some cases, local governments are involved heavily in the development of the base by means of political and monetary power. Farmer communities may also initiate this base organization, which often has cluster-like relations behind such communities. The advantages of the base approach are that farmers preserve their contracted land use rights, meanwhile obtain stable and reliable material inputs and selling agreement for after-harvest. Farmers are also secure in having technical assistance during the production process. The base is hence in favour of experiments on new technologies and diffusion of new techniques. The base approach is, however, not free from problems. On the one hand, farmers, as a weak group, sometimes get depressed for they are forced to accept unreasonably low prices set by vendors. On the other hand, vendors get losses when farmers are allured by other buyers offering better prices and infringe the implementation of contracts. This illustrates that coordination by the government for the enforcement of appropriate contracts is quite necessary.

One crucial element is the policy and managerial capability in identifying bottlenecks in technology, capital, market and institutions. With limited resources, policies have to give guidance towards the most seriously pending issues, which if solved appropriately, will bring about breakthroughs in transformation, or otherwise improvements will get blocked. Institutional innovation, technological innovation, market innovation or combination of them is indispensable to get through the bottlenecks identified. Successful development should be based on active responses from the actors of the agricultural innovation system: farmers, firms, technological institutes and related government agents. The Government could improve innovation greatly by providing various necessary service functions and through policies that encourage innovation. Local Governments need to be proactive to remove obstacles to agricultural transformation through policies in favour of market development, technology development, importation of technology and capital.

Policies that favour agricultural innovation alone do not ensure success in agricultural development in the absence of supporting functions and complementarities. The provision of seed, pesticide, fertiliser and other input materials is must in a continuous manner. The post harvest management and processing of agricultural products are also important for the expansion of value-chains around the agriculture sector. Knowledge, necessary for local development, needs to be introduced through various means, which work together with local persons including farmers. These are much like complementary assets which are necessary for the realization of economic returns by a vendor following an innovative technology. This is obviously a systematic perspective. What is unique to the development or transition context is that many complementary assets do not exist beforehand. Policies have to consider the need for the creation of complementary activities and related institutions. In all the market systems, development of upstream and downstream manufactures, and expansion of services are so critical for the success in agricultural production innovation, and all these are to be attributed to the policy initiatives and coordination by the local governments. The transformation of agricultural economy is a complicated process. Simplified imitation of a certain initiative working successfully somewhere else, may in all probability lead to failure. The learning of experiences elsewhere has to incorporate the local conditions, and timing and opportunity play a part in success as well.

Agriculture is the foremost sector to free the nation of these persisting maladies. This Congress will provide an intellectually rich multi- stakeholder platform for discussing and critically analyzing veritable disruptive innovations for transforming agriculture and food systems to reshape India. It will showcase agriculture not only as the main source of employment and livelihood security for nearly 50 percent of India's population, bulging to be the largest in the world by 2025, but also as a business opportunity, service provider, industry, and ecosystem protector.

Reflecting on the journey from the Green Revolution to the Gene Revolution, the Congress will underpin the need for innovations to drive congruent acceleration of productivity, profitability, sustainability, and inclusivity. Besides leaps in genetic enhancement, innovations in precision agriculture, natural resource management, climate smart agriculture, mechanization, micro-irrigation (per drop more crop), ICT, digital technology, farmer-market linkage, value chain and post-harvest management, renewable energy, price realization, and, of course, farmers' net income will be duly discussed.

Along with innovative technologies, the Congress will examine and identify the uncommon synergistic transformative policies, strategies, institutions, partnerships, processes, products, investments, business models, trade, group dynamics (FPOs, cooperatives), and human resources development. Further, in this fast changing globalized world, and keeping in mind the increasing appreciation of local-global interdependence, increasing volatilities of climate change, achieving the SDGs by 2030, the Zero Hunger Challenge and the Paris Declaration, the Congress will analyze the scope of international partnership toward creating Evergreen Revolution for Evergreen Economy.

(Panjab Singh)
President

106th Executive Council Meeting

The 106th meeting of the Executive Council (EC) was held on November, 2018 and was chaired by Prof Panjab Singh, President, NAAS. After a brief welcome by the President and before taking up the scheduled agenda of the EC, the Agricultural Science Congress (ASC) team, represented by Dr A.K. Singh, Organizing Secretary; Dr D.K. Yadava, Jt. Organizing Secretary and Dr (Ms) Shelly Praveen, Treasurer, XIV-ASC, gave an update to the EC about the status of preparations/progress of the ASC. All the issues including financial component of organisation of ASC were deliberated at length and wherever corrective measures were required, EC gave its suggestions. After this, the listed agenda were discussed in detail and approval accorded wherever necessary. Some of the important decisions included approval of members of the executive council, Fellows and associates for the year 2019; NAAS awards; NAAS programmes; Calendar of Activities scheduled for the year 2019; Consideration of the recommendation of NAAS Journal Scoring Committee and Felicitations of outgoing Office Bearers and Members of the Executive Council, 2018.

Election of the Office Bearers and Members of Executive Council

Dr Trilochan Mohapatra	Vice-President
Dr Rakesh Kumar Jain	Treasurer
Dr Uma Shankar Singh	Foreign Secretary
Dr Madhoolika Agrawal	Member
Dr Arvind Kumar	Member
Dr Brahma Singh	Member
Dr Rajeev K. Varshney	Member

Election of Fellowship and Selection of Associates

Fellowship

Section I: Crop Sciences

1. Dr Bakshi Ram
2. Dr Ravish Chatrath
3. Dr Kunwar Harendra Singh
4. Dr Swarup Kumar Parida
5. Dr Sudesh Kumar Yadav
6. Dr Raman Meenakshi Sundaram

Section II: Horticultural Sciences

1. Dr Arun Kumar Singh
2. Dr Debasis Pattanayak
3. Dr (Ms) Kambham Madhavi Reddy

Section III: Animal Sciences

1. Dr Devendra Tarachand Mourya
2. Dr (Ms) Sushila Maan
3. Dr Amrish Kumar Tyagi
4. Dr Bhupendra Nath Tripathi

Section IV: Fisheries Sciences

1. Dr Priyabrat Swain
2. Dr Basanta Kumar Das

Section V: Natural Resources Management Sciences

1. Dr Pawan Kumar Joshi
2. Dr Anup Das
3. Dr Dinabandhu Sahoo
4. Dr Tapas Kumar Das
5. Dr Tapan Jyoti Purakayastha

Section VI: Plant Protection Sciences

1. Dr Sunil Kumar Khare
2. Dr (Ms) Neera Singh
3. Dr Mukesh Kumar Dhillon
4. Dr (Ms) Rashmi Aggarwal

Section VII: Agricultural Engineering & Tech.

1. Dr Krishna Pratap Singh
2. Dr C. Anandharamakrishnan

Section VIII: Social Sciences

1. Dr Ranjay Kumar Singh
2. Dr Akhilesh Chandra Kulshreshtha

Foreign Fellows

1. Dr Abdelbagi M. Ismail (Kenya)
2. Dr Hosahalli Ramaswamy (Canada)

Pravasi Fellow - None

Associates

	Name	Section
1.	Dr R. Deb	Animal Sciences
2.	Dr B.S. Gotyal	Plant Protection
3.	Dr P.L. Kashyap	Plant Protection
4.	Dr Neeraj Kumar	Fisheries Sciences
5.	Dr C.O. Mohan	Fisheries Sciences
6.	Dr B. Parameswari	Plant Protection
7.	Dr A.K. Parihar	Crop Sciences
8.	Dr R. Ranjan	Animal Sciences
9.	Dr Sarika	Social Sciences
10.	Dr S. Sood	Crop Sciences

Academy Awards for the Biennium 2017-18

Name of Award	Awardee
Memorial Award	
Dr B.P. Pal Award for Excellence in Agricultural Sciences	Prof. Ram Badan Singh, Immediate Past Chancellor, CAU
Dr K. Ramiah Award	Dr Kailash Chander Bansal, Former Director, NBPGR, New Delhi
Dr K.C. Mehta Award	Dr Appa Rao Podile, Vice Chancellor, University of Hyderabad, Hyderabad
Dr M.S. Randhawa Award	Dr Probir Kumar Ghosh, National Coordinator, National Agricultural Higher Education Project, ICAR, New Delhi
Dr N.S. Randhawa Award	Dr Biswapati Mandal, Professor, Bidhan Chandra Krishi Viswavidyalaya, Nadia, W.B.
Dr P. Bhattacharya Award	Dr Sudershan Kumar Bhatia, Professor (Retd), HAU
Endowment Award	
Shri L.C. Sikka Endowment Award	Dr Bijendra Singh, Director, ICAR-Indian Institute of Vegetable Research, Varanasi, U.P.
Dr (Ms) Prem Dureja Endowment Award	Dr (Ms) Chandish R Ballal, Director, ICAR-National Bureau of Agricultural Insect Resources, Bengaluru
Dr N.G.P. Rao Endowment Award	Dr A.T. Sadashiva, Principal Scientist & Head, Division of Vegetable Crops, ICAR-Indian Institute of Horticultural Research, Bengaluru
Recognition Award	
Plant Improvement	Dr D.K. Yadava, Principal Scientist & Head, Division of Seed Science & Technology, ICAR-IARI, New Delhi
Plant Protection	Dr Kaushik Banerjee, Principal Scientist, ICAR-National Research Centre for Grapes, Pune, Maharashtra
Soil, Water & Environmental Sciences	Dr R. Dinesh, Principal Scientist, ICAR-Indian Institute of Spices Research, Kozhikode, Kerala
Animal Sciences	Dr K.K. Krishnani, Principal Scientist, ICAR-Central Institute of Fisheries Education, Versova, Mumbai, Maharashtra
Agricultural Engineering & Technology	None
Social Sciences	Dr Hukum Chandra, ICAR National Fellow, ICAR-Indian Agricultural Statistics Research Institute, New Delhi
Young Scientist Award	
Plant Improvement	Dr S.K. Upadhyay, Assistant Professor, Department of Botany, Panjab University, Chandigarh
Plant Protection	Dr D.M. Firake, Scientist (Agricultural Entomology), Division of Crop Protection, ICAR Research Complex for NEH Region, Umiam, Meghalaya
Soil, Water & Environmental Sciences	Dr Vijay Pooniya, Scientist (Sr Scale), Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi
Animal Sciences	Dr Subrota Hati, Assistant Professor, Department of Dairy Microbiology, SMC College of Dairy Science, Anand Agricultural University, Anand, Gujarat
Agricultural Engineering & Technology	Dr V.E. Nambi, Scientist, ICAR-Central Institute of Post-harvest Engineering & Technology (CIPHET), Ludhiana
Social Sciences	Dr E. Varghese, Scientist, Fishery Resource Assessment Division, ICAR-Central Marine Fisheries Research Institute, Kochi, Kerala

Strategy Workshop on "Development and Adoption of Novel Fertilizer Materials"

A Strategy Workshop on "Development and Adoption of Novel Fertilizer Materials" was held on 5th October, 2018 to deliberate on the various issues that need to be addressed, in order to develop a temperamentally improved scientific

environment in India for novel fertilizer materials and new technologies. The workshop was Chaired by Dr I.P. Abrol and Convened by Dr Chandrika Varadachari. The workshop included participants representing NAAS, ICAR Institutes, Fertilizer Companies and other officials.

There was broad consensus amongst the participants that (a) there is a need for improved fertilizers because of the low efficiency and other problems with the current fertilizers, (b) materials and technologies are available to confront this problem, (c) it is necessary to improve the regulatory systems, which are creating a bottleneck, and (d) research and educational inputs need to be addressed to provide the requisite support for innovative materials.

Agriculture being a mainstay of the Indian economy, fertilizers and their consumption and use have a substantial impact on our economy. Fertilizer imports in 2016-17 was nearly 14 Mt of which Urea constituted the largest proportion at 5.5 Mt followed by DAP at 4.4 Mt. Urea is reported to suffer 50-70% losses due to leaching, volatilization as ammonia, leaching after transformation to nitrate and denitrification to NOx. Phosphates and micronutrients also have low use-efficiencies due to fixation reactions. This is causing environmental pollution of both water and air, besides a huge loss to the exchequer (>Rs 50,000 crores) and to the farmer who is losing more than 50% of his investment in fertilizers. Other issues with present fertilizers include incompatibility between materials that makes it difficult to make composite combinations, handling and application, hygroscopicity, incompatibility with applicators, etc. With micronutrient fertilizers, some of these challenges are more magnified; utilization efficiencies are < 10% and lead pollution in zinc sulphate industries as one of the most serious concern.

Although many new technologies are available globally, but they are not available to Indian farmers. These include urea polymers, coated urea, gel-based polymers, urease and nitrification inhibitors, liquid application phosphates, different potassium sulphates, etc. Indigenous technologies including smart fertilizers, nano fertilizers and potash recovery from mica wastes are also available. Such improved fertilizers can solve many of the problems including improving use-efficiency, crop yields and reducing pollution.

It was suggested that the entire regulatory process, including the Fertilizer Control Order (FCO) and the existing quality control measures need to be thoroughly reformed with zero compromise to farmer's interest and the environment. The FCO, adopted for the purpose of keeping a tab on subsidized products, has outlived its relevance and has proved to be a formidable red-tape barrier to introduction of new fertilizers. The Order should be replaced by an Act, similar to that for seeds (Seeds Act) and insecticides (Insecticides Act). Field trial requirements of new products should be clearly defined and protocols for such trials should be in accordance with the requirements for that product. Mere formulations of existing products should not be subjected to a lengthy process of approval. The quality control process adopted for fertilizers should be similar to that for drugs. A Fertilizer Regulatory Authority would focus on quality of fertilizers to ensure that soil health is not adversely affected. Companies would provide information on product composition, its method of application, methods to determine quality, etc., to the Ministry of Agriculture in advance. Quality control should be on the basis of Label claim on product packs declared by marketers, as with food or drugs.

The participants were of the view that major constraint is that quality control laboratories that are far short of requirement in both manpower and instrumentation. The present capacity of Quality Control Laboratories in only 1.7 lakh samples whereas the total number of samples is about 17 lakhs. Laboratories are also ill-equipped to deal with new products that would require more sophisticated instruments. To deal with such situations, a few high-tech Fertilizer Control Laboratories could be setup to monitor fertilizers sold in the market. These laboratories will analyse randomly picked samples to check with the label claims of the manufacturer. Thus, the onus will be on the manufacturer to analyse each production batch and have it confirmed to standards. Periodic check of samples for matching with label claims of manufacturer will ensure desired quality of products as per standards.

The existing subsidy policy was highlighted as a huge hurdle in the way of new, innovative and efficient fertilizers. Since subsidy is allowed only on select fertilizers, thus ignoring many new fertilizers, even if they are more efficient and effective, they cannot compete in the market with subsidized products. This policy is also discouraging investment in R&D by companies and not providing an environment favourable to innovation. Therefore, the subsidy structure has to be rationalized by subsidizing nutrients per se and particularly complex,

customized fertilizers that will deliver NPK mixtures suited to particular crops. Subsidy on fertilizers should be determined by the individual State Governments depending upon its relevance to crops grown there. Freedom should be provided to states to decide the fertilizers critical for crop production and subsidy should be announced accordingly. This will minimize the discrimination done to farmers by way of national subsidy of select fertilizers that goes in favour of resource rich states and its farmers. Agriculture growth and sustenance should be left to State Government for market driven approach. State governments should choose to subsidise nutrients in which their soils are most deficient. Extent of subsidy should also vary depending on size of farmer's land-holding and income. Smaller farmers in lower income should receive more subsidy and this should be reduced for large farmers.

It emerged from the discussion that novel fertilizer materials are expected to possess patent rights. At present, there is a lot of misunderstanding with fertilizer companies that grant of FCO gives a free right to production and sale regardless of patent status. This is a worrisome situation for innovators. The FCO has no scope to clarify patent protected fertilizers. All government agencies involved in granting licenses to manufacture or sales must give due cognizance to the secrecy of know-how and process details involved in manufacture of patented fertilizers. The FCO or an alternative Act if made, should also clarify that inclusion of a new fertilizer in any schedule does not remove the requirement for obtaining a license from the patent holder.

It was recommended that India needs to innovate new fertilizer materials and develop into a fertilizer research hub. At present, there is no research institute, or any other organisation in India devoted to fertilizer technologies and new fertilizer development. Import of new fertilizer technologies will require engineering R&D support for adaptation of new technologies. R&D centres at Universities and research institutes have to be set up for the purpose of developing new fertilizer materials. A need for introduction of special courses to teach fertilizer chemistry and technology was felt at degree level.

Finally, it was concluded that India must strive to develop into a fertilizer technology export base in design of new products including their components and intermediates, besides in engineering and design of fertilizer plants.

Application of Sensors in Indian Agriculture

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India occupies approximately 201 million hectares of total cropped area producing 285 million tons of food grains and 307 million tons of horticultural produce in 2017-18. India need to enhance its food production to feed its increasing human and animal population and take care of its other requirements. In order to sustain the agriculture production and take care of the environmental and the cost factors, the production needs to come from limited areas since a sizable land will be diverted to forests, industry and dwelling purposes. Therefore, both genetic and non-genetic factors need to be taken care of for the required production. Precision agriculture with explicit inputs for maximum production, without any penalty to the environment will be the key to achieving the self-sufficiency in food production while taking care of the exports, industrial requirements and environment. In this context, sensing technologies provide actionable data to be processed and implemented as per need to optimize crop yield while minimizing environmental effects.

Sensing technologies will also help for better nutrition and improved self-life for sustainability with minimal environmental impact by reducing the application of harmful agro-chemicals. Currently, an array of sensor technologies are utilized in modern agriculture to obtain accurate and real time information on chemical and physical nature of plants, crop maturity, fruit ripening, prediction of disease, nutrient, weather and soil conditions (Figure 1). The spectrum of sensing technologies ranges from electrochemical sensors, biosensors, dielectric sensors, electronic nose (e-nose) sensors and wire-less sensors coupled with e-nose. Out of all these sensing technologies, e-nose technology has been most widely used in the field of agriculture. However, development of e-nose coupled with wireless communication for easy integration with smart phones and robotics to facilitate low cost precision agriculture is still lacking. The biosensors, used to measure chemical reactions, can be used to identify enzymes, protein, antigens, microorganisms and nucleic acids. Through analyzing this information, the diseases and insect-pests can be sensed. Some biosensors used/ available in agriculture are bioaffinity biosensors, biocatalytic biosensors, electrochemical biosensors, fiber-optic biosensors and piezoelectric biosensors. An attempt has been made here to provide a brief overview of the diversity of uses for sensor technologies in the agricultural sector for production, protection, harvest, post-harvest processing and storage and marketing of agricultural produce.

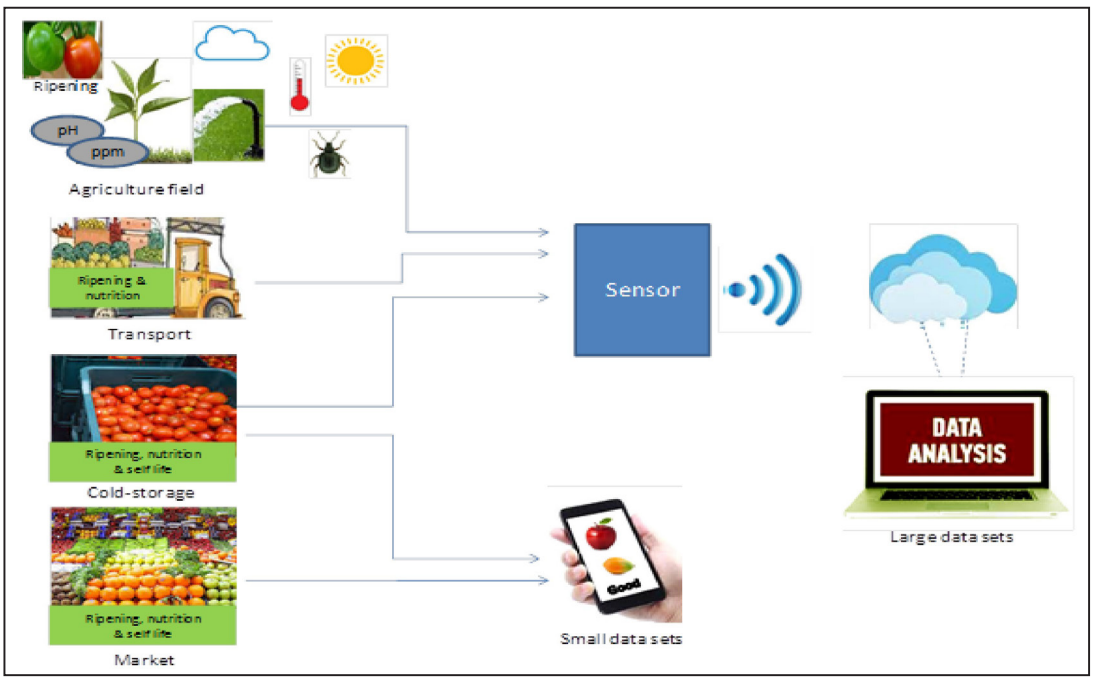

Figure 1: Sensor applications in agriculture

Based upon the physiological conditions, plant synthesize a very large range of organic and inorganic compounds, which accumulate within specialized cells of plant tissues, such as in the root, stems, leaves, flowers and fruits. Among these compounds, relatively small molecular weight organic compounds (molecular weight < 350 Daltons) bearing various polar and no-polar functional groups constitute the Volatile Organic Compounds (VOCs). Each plant has some general VOCs that are mostly common to all the plants and some signature VOCs, which are specific and limited to certain taxonomic group produced as a result of the particular physiological / metabolic process within that specific taxonomic group. These general or signature VOCs are particularly conducive to e-nose sensor detection by transducer. Mostly Metal Oxides (MOs) are preferred as e-nose transducer. The detection of these VOCs using e-nose devices usually is targeted to assess one or more signature emitting from the plant source. Characterizing the source of a sample may be done for the specific purposes of determining product quality, nutrition, purity, aroma, maturity, self-life, and pesticide or disease conditions. For example, some of the commercial e-noses as listed in Table 1 are used to evaluate fruit freshness, harvesting time, ripeness, nutrition, shelf-life and post-harvest quality monitoring. The fruit ripening prediction and aroma characteristics of agricultural products contribute immensely to food value and attractive appeal to consumers and thereby often determine the high saleability of agri-products. However, the e-noses are still too expensive for commercial use and are composed of fixed hardware, thereby limiting their use in specific applications.

Table 1. Commercially available e-noses used in agriculture

E-nose and its application	Working mechanism
Plant Taxonomy	
Aromascan A32S	• Identifications of plants and chemo-taxonomy. • Pesticide determination
Plant Pathology	
LibraNose 2.1	• Wood decay and fungi ID
Cyranose 320	• Post-harvest disease detection • Self-life detection in selected fruits
Quality in Fruits/ agri-products	
EOS 835	• Fruit variety • Toxin contamination
A-nose	• Coffee aroma detection
Z-nose 7100	• Detection of contamination in coconut oil
FOX 4000	• Post-harvest treatments in rosaceous fruits
e-Nose 4000	• Postharvest handling treatments effect
Libra Nose	• Self life in peach
EOS835	• Ripening stage after harvest in Apricot
ATR-FTIR	• Juice adulteration
PEN2	• Strawberry quality
enQbe	• Grape quality

Sensors for water and soils

Soil plays an important and fundamental role in crop yield and quality, both through its intrinsic properties and because of external factors. Soil elements (nitrogen, potassium, carbon and organic matter) and salinity could be remotely measured by electrical conductivity sensor. Automated soil resistivity profile analyzer coupled with GPS system are routinely used in grape orchards to assess the variability patterns of plant growth and yield based on the analysis of soil electrical resistivity. Image analysis sensing for soil characteristic is an emerging image based promising technology due to its very low operating cost.

Sensors for diseases, insect-pests and weeds

The losses due to diseases, insect-pests and weeds are more than 25% in different agricultural commodities. A real time sensing system can help in reducing the losses by timely and precise application of fungicides, insecticide and weedicides. IoT (Internet of Thing) is a viable approach for monitoring and decision making process for diseases and insect-pests in crop plants. Machine learning based on detection and recognition can provide clues to identify and treat diseases and insect-pests. The hyperspectral imaging could be used as a fast, non-destructive and reliable technique to detect plant diseases on stems.

Sensors for timely harvesting and quality

The maturity level of grains and fruits determines the shelf life and future rate of quality loss due to changes in flavour, firmness and colour. Harvesting fruits at an optimal physiological condition ensures good quality at a later stage, enhancing a number of quality traits that extend the shelf life, slow rate of decline of firmness or texture, and maintain a preferred level of flavour and overall appearance.

Agronomic uses of e-nose sensor mainly include analyses of fruit ripening and harvesting time, post-harvest quality analyses, crop-protection applications to detect harmful pesticides and microbes, selections of plant cultivars for planting, monitoring plant quality in aseptic plant tissue conditions and green house for production of commercially important plant products. E-nose finds strong applications in assessing fruit qualities like flavour, colour, aroma, texture and nutritional quality. Ripening can be assessed by several destructive techniques, however non-destructive techniques based on VOC analysis are the preferred ones because of convenience and cost. The VOC-based e-noses have been successfully used to characterize various developmental stages in ripening of strawberry fruit and different cultivars of mangoes, besides to determine the right stage of maturity and to monitor the shelf life of tomatoes.

Sensors for storage, transport and marketing

E-nose application in aroma monitoring of agri-products is an emerging area of research. Several studies have demonstrated that the aroma emitted by fruits/ agri-products can indicate the maturity level and thus quality of marketed product. In a recent study aroma volatiles of rosaceous fruits were collected and analyzed by metal-oxide gas sensor array. Libra Nose sensor is currently used to successfully discriminate peach fruits based on aroma under post-harvest storages. As cold storage of fruits proceeded, linking degree and especially aroma declined for each cultivar tested. Cultivars showed different behaviour pattern for linking degree and especially aroma during cold storage. The availability of commercial peach cultivars which withstand long term storage period allowed far markets to be reached with high quality standards. Similarly, commercial e-noses are under trial to determine quality and aroma of coffee beans based of VOC emission. E-nose as a means of monitoring fruit freshness and shelf life prior to marketing can have a number of benefits that maximize corporate profits and optimize customer satisfaction. Information from e-nose on fruit physiological status, based on changes in released volatiles, can be applied to retard the

Figure 2: SMART-Fruit Nose developed by IIT Roorkee

ripening process through ripening inhibitors at appropriate time and adjusting storage conditions to preclude ethylene accumulation. This will prevent the post-harvest losses during storage and transport. Researchers at IIT Roorkee have developed a prototype of SMART-phone based sensor to predict sensing parameters such as ripening, diseases and selected nutritional factors (sugar, protein, fat, polyphenol) in apple and papaya. This sensor is composed of an array of metal oxides as hybrid transducer, which can sense signature VOC emitting from apple and papaya during harvesting and post-harvesting conditions (Figure 2). This way a single SMART-Fruit nose sensor can be used in apple orchards during transport, storage and marketing.

Conclusions

In conclusion, several electronic sensor devices have been utilized in a wide diversity of applications in the agriculture field and related industries to improve the productivity, quality and effectiveness of agri-products while concurrently helping to avoid the adverse effects of pesticides and pathogens. The challenges for the future are to further develop sensor technologies to expand potential applications in wider community through development of smaller, portable low cost devices integrated with wireless communication and high-speed data processing for improved field applications. The potential for future developments and new applications-based e-noses is enormous and expected to open *de novo* cost effective solutions to several agricultural problems.

Activities of Regional Chapters

Ludhiana Chapter

A 'Brainstorming Workshop on Crop Residue Management' was organized by Ludhiana Chapter of National Academy of Agricultural Sciences (NAAS) at PAU, Ludhiana, on September 6, 2018. The highlight of the workshop was the key lecture delivered by Dr J.S. Samra, Former CEO, National Rainfed Area Authority, Planning Commission/Niti Aayog (GOI) on ***'Generation of Bio CNG (methane), manure, income, employment and clean environment from agro-waste'.***

Dr N.S Bains, Director Research, PAU welcomed Dr J.S. Samra, Guest of Honour, other dignitaries, and delegates. Dr B.S. Dhillon, Vice Chancellor, PAU Ludhiana and Convener, Ludhiana Chapter, NAAS was the Chief Guest. Other dignitaries who participated the Brain Storming Session included Dr A.S. Nanda, Vice-Chancellor, GADVASU; Dr S.M. Virmani, Adjunct Professor, PAU; Dr S.K. Singh, Director, National Bureau of Soil Survey and Land Use Planning, Nagpur; Dr Rajvir Singh, Director ICAR-ATARI, and NAAS Fellows. The Deans, Directors and Heads of the departments from the PAU, scientists from ICAR-ATARI, ICAR-CIPHET, GADVASU, Borlaug Institute for South Asia (BISA) and PAU, besides scientists and officials from the Corporate Sector also attended the workshop.

Initiating the presentations, Dr J.S. Mahal, Director Extension Education, PAU discussed the technologies developed for paddy straw management by PAU for *in-situ* mulching and incorporation and its baling. Pros and cons of different technologies were discussed. He highlighted the complementary role of various farm machines like PAU Straw Management System, PAU Happy Seeder and Straw Cutter-cum-Spreader for paddy straw management. He also mentioned that with the development of short duration rice varieties by PAU, farmers have been provided an adequate window for straw management and, therefore, retention/incorporation of rice straw in soil is feasible as well as desirable.

The Guest of Honour & Key Speaker, Dr J.S. Samra made a presentation on 'Generation of BioCNG (methane), manure, income, employment and clean environment from agro-waste'. He was of the view that BioCNG production under anaerobic conditions in leak proof steel digesters and collection of methane gas in cylinders can result in reducing pollution and thereby global warming and also would cut down fuel imports, as BioCNG has the same standards as fossil CNG with 98 per cent methane and S<10ppm. Further, the by-products i.e slurry and bio-compost produced retain all the nutrients and can be returned to the soil to maintain its health. He stressed that bio-compost is in no way inferior to farm yard manure. Dr Samra informed that Indian Oil Corporation Limited (IOCL) has signed MOU with Punjab Government to set up 400 BioCNG plants in the state and it will set up 100 BioCNG units in Haryana.

Dr Manju Wadhawa, Head, Department of Animal Nutrition, GADVASU; Dr H.S Sidhu from BISA; Dr Anil Kumar from CCS-HAU; Shri Sreejit Basu from IOCL and Er Sanjeev Nagpal from Sampuran Agri Ventures Pvt. Ltd also made presentations followed by open discussion on various options and status of crop residue management.

Following points emerged from the workshop:

1. All the options available for crop residue management should be promoted to manage such a huge quantity of straw available in the region.
2. With the burning of rice straw residues, NOx and Particular Matter (PM) are produced which have the highest global warming potentials. Hence, paddy straw should be managed *in-situ* and/or *ex-situ* rather than burning. The emissions can be considerably reduced with the use of Bio-CNG instead of using petrol/CNG in heavy vehicles.
3. Carbon-Nitrogen (C/N) ratio of feed material for raw biogas production is very important parameter, hence the crop residues having more C/N ratio must be mixed with other material having low C/N ratio like animal dung to make a feed having ideal C/N ratio of 25-30 required for efficient gas production. Further research should aim at working out optimal combination of feed material. Researchers should determine the properties of all feedstock available in the region for biogas generation
4. *Ex-situ* options (e.g. baling) involve almost double the cost of *in-situ* options (e.g. happy seeder) for paddy straw management. The comparative economics after factoring-in BioCNG and compost production needs to worked out under different scenarios.
5. For efficient biogas generation, pre-treatment of straw like particle size reduction is must, hence research should be conducted for various mechanical interventions/ pretreatments.
6. Rice straw can also be used as animal feed through natural fermentation process as it acts as maintenance ration and partly meets production requirements. Fermented rice straw has a shelf life of more than a year; it improves milk production, conception rate and overall health of animals. Collaborative research should be conducted to mechanize the fermentation technology.
7. Various training programmes should be organized on the repair and maintenance of agricultural machinery developed for paddy straw management and their popularization for the straw management.

A lecture from Dr P.K. Ghosh, National Coordinator, NAHEP (ICAR) on ***'Sustainability Concern in Indian Agriculture: Needs Science-led Innovation',*** was organized at Punjab Agricultural University, by Ludhiana Chapter of NAAS on October 30, 2018. The lecture was attended by Dr B.S. Dhillon, Vice Chancellor, PAU and Convener of the Ludhiana Chapter of the NAAS; Dr A.S. Nanda, Vice Chancellor,

Guru AngadDev Veterinary and Animal Sciences University (GADVASU); Dr SujoyRakshit, ICAR-IIMR; NAAS Fellows, Deans, Directors and officers from the PAU; faculty from GADVASU, CIPHET, IIMR, ATARI and PAU, and also by officers from the line departments, and the students.

At the onset, Dr B.S. Dhillon welcomed and introduced Dr Ghosh in his opening remarks highlighting his significant contributions in areas of soil fertility and fertilizer use, crop nutrition and soil quality, conservation agriculture, soil and water conservation, feed and fodder resources.

Dr Ghosh made a presentation highlighting the broad contours of the agricultural production system in the country defined by the need to achieve food security and called for close attention to rice-wheat cropping system of the Indo-Gangetic Plains (IGP) whose sustainability is under threat. He focussed on degradation of natural resources, severe biotic and abiotic stresses especially drought, floods, pest infestations with accompanying impacts on biodiversity and agricultural productivity as major constraints to agricultural development. He drew attention to climate change that has gained significant global attention over the past decade due to concerns of its deleterious long-term impact on agriculture, environmental issues and human welfare for redressal on priority. He was of the view that understanding long-term soil organic carbon (SOC) changes in various agro-ecologies is

important because it directly affects soil quality and serves as a major reservoir of plant nutrients. In this context, he mentioned agricultural practices with a profound positive effect on SOC content such as cover crops and fallowing, agro forestry and agro-pastoral systems, rotations with deep-rooted crops, and crop residue management or mulching and conservation tillage practices . He called for inclusion of pulse crop as a component of INM to conserve natural resources, maintain soil health and increase soil organic carbon though leaf drop and root biomass.

The agricultural technology needs to move from production to profit oriented sustainable farming practices. Now is the time to explore the potential and importance of these practices not only for their economic significance but also as the basis for further intensification and ecological sustainability. The intensification of ecological agriculture is now required as it has the potential to sustainably feed the growing population by bringing 'Evergreen revolution' based on sustainable thinking.

He shared that small-farm management to improve productivity, profitability and sustainability of the farming system will go a long way to ensure all round sustainability. It has been observed that for a country like India, the practice of sustainable agriculture is very important as it accelerates the productivity, efficiency, employment, and provide guidance to reduce the practices which affect the quality of soil, water resources and degradation of other natural resources. In sum, if the focus of policies is on investment and infrastructure, land and water management, technology and market reforms, agriculture can contribute to (i) environmental services such as soil conservation, watershed services, biodiversity, and carbon sequestration; (ii) poverty reduction; (iii) food security; (iv) agriculture as a buffer in times of crisis, and (v) social viability.

Dr Ghosh concluded that India needs to produce more, better, safe and diverse food from less land for more people, which is possible through enhanced productivity and efficiency. Further, he pointed out that second green revolution is in the offing and, that unlike first green revolution, is likely to come through multiple interventions through 'science led agriculture'. He stressed on adoption of holistic approach by integrating research, education and extension for achieving enhanced productivity and efficiency, by connecting farmers, producers, consumers and entrepreneurs.

Dr A.S. Nanda, VC (GADVASU) thanked Dr Ghosh for delivering an inspirational talk with many take home messages for agricultural scientists.

Hyderabad Chapter

A "Krishi Kala Utsav" was organized by NAAS-Hyderabad Chapter in association with ICAR-NAARM during October 27, 2018 to November, 2, 2018 at ICAR-NAARM, Hyderabad.

There are different ways of communication in extension science. Art work is one of the most captivating ways to

communicate and capture the imagination of the viewer. Art works are particularly attractive to young minds. The pictures convey and deliver the content to the mind faster and better than through lectures or other forms of communication.

In order to create works of art to capture successful journey of Indian agriculture and integrated farming systems which can be showcased to various trainees at NAARM, a residential art workshop (Krishi Kala Workshop) was organized during Oct 27 – Nov 02, 2018 by ICAR- NAARM in association with NAAS-Hyderabad Chapter. For this, a team of 23 artists of Sir J.J. School of Arts accompanied by faculty, Prof Ananth Nikam and Smt Shilpa Nikam & Shri Deepak Khogre, ACTO (Artist), ICAR-CIFE, Mumbai were invited to stay and create customized works of art - paintings. Fifty two paintings have been generated through this workshop. This exercise is a sequel of the same experiment which was organized and immensely appreciated during 2017 at NAARM.

Dr Ch. Srinivasa Rao, Director, ICAR-NAARM, Hyderabad and Convener, Hyderabad Chapter inaugurated the Utsav on 27 October, 2018 at NAARM Campus and presented the success of agriculture and allied sectors in India towards food secured nation. Dr B.S. Sontakki, HoD, Extension Division & Director I/c NAARM, Hyderabad presided over the valediction on 2nd November, 2018.

Dr M. Krishnan, HoD, ESM Division, Dr S. Senthil Vinayagam, Principal Scientist and Shri P. Namdev, Artist, ICAR-NAARM were the program directors.

Patna Chapter

A National seminar on "Challenges and Opportunities for Farmers' Prosperity in Hill Agriculture" was jointly organized by NAAS, New Delhi, ICAR-RC for NEH, Umiam, International Maize and Wheat Improvement Centre (CIMMYT), New Delhi, and Indian Association of Hill Farming, Umiam at ICAR-RC for NEH Region, Umiam, during 29-30th November 2018.

During inaugural welcome session on 29th November, 2018, Shri Wailadmiki Shylla, Hon'ble MLA, Jowai, Meghalaya, stressed the ways to explore the potentials of the region and ensure maximum benefits from agriculture without harming

the natural ecosystem. Dr N. Prakash, Director, ICAR-RC for NEH Region advocated to make a roadmap for exploring the differences between hill and plain agriculture. Dr B. P. Bhatt, Director, ICAR-RCER, Patna, presented a plenary lecture on "Issues and Strategies for Agricultural Development in the Eastern Himalayan Region" and emphasized on having more extensive research for the development of hill agriculture and taking forward the potential technologies and practices.

The first technical session on "Frontier Technological Options for Hill Agriculture" was chaired by Dr N. Prakash, co-chaired by Dr N.B. Singh and coordinated by Dr A.K. Jha. The issues and strategies were discussed by different eminent speakers, On 30th November, 2018, the second technical session on "Issues and Strategies for Agricultural Development in NEH Region including Potential Farming/ Cropping Systems, Organic Agriculture" was chaired by Dr A. Arunachalam, ADG (International Relations), ICAR, New Delhi, co-chaired by Dr M. L. Jat, CIMMYT, New Delhi, India and coordinated by Dr R. Laha, Principal Scientist (Animal Health), ICAR-RC for NEH, Umiam. The major issues/challenges of different NE states in hill agriculture were discussed by various researchers.

In the third and final technical session, a panel discussion on the roadmap for scaling sustainable and resilient agricultural technologies in hill agriculture was held. The session was moderated by Dr B. P. Bhatt and Dr A. Arunachalam. The panelists of the session were Director, ICAR-RC for NEH Region, Umiam, Director, ICAR-VPKAS, Almora, Dean, CPGS (CAU), Umiam, Director, ICAR-ATARI, Guwahati, Director, ICAR-ATARI, Umiam, Meghalaya, JDs of ICAR-RC for NEH Regions of Nagaland, Sikkim, Arunachal Pradesh, Manipur, Mizoram, and Tripura Centres, Prof Sapu Chankija, SASRD Campus, Nagaland University, Dr M.L. Jat, CIMMYT, Dr S. Bandhopadhyaya, Pr. Scientist & Head, IVRI Regional Station, Kolkata and Prof Dwipendra Thakuria, Associate Professor, CAU, Umiam, Meghalaya. The following points were taken up to initiate roadmap for scaling up of hill agriculture:

- Assessment of technology adoption gaps
- Human resource development and capacity building
- Showcasing of proven technologies
- Expansion of poultry and pig farming in the state
- Year round vegetable production through low cost polyhouse
- Community based approach for development of agriculture in IFS mode (integration of pig and poultry component)
- Technology based cropping system through awareness and input support system for IOFS and seed chain development
- Secondary Agriculture
- Commodity based Processing Unit
- Seed Production programme

The concluding session of the two day national seminar was chaired by Dr A. Pattanayak, Director, ICAR-VPKAS, Almora and co-chaired by Dr U. K. Behera, Dean, College of Agriculture, CAU, Umiam. Based on the deliberations, following salient recommendations were made:

- ICAR-RC for NEH should initiate the generation of spatial database along with statistics on land use pattern, area under shifting cultivation, abundant Jhum, current fallow, net sown area (upland & low lands), forest areas (open/ dense) etc. using finer resolution recent satellite data for regional scale (NE India).
- Emphasis should be laid on extreme climatic variability and development of forecasting system and mitigation strategies.
- Development of bio-intensive production system models in horticultural crops in rainfed scenario: basin enrichment, multitier production system, use of microbial consortia in fruit crops.
- Promotion of ecologically and economically viable indigenous farming systems across the agro-climatic zones for employment generation, environmental conservation besides food and nutritional security.
- Promotion of fodder cultivation, increased maize cultivable area and use of location- specific feed and fodder resources to meet the fodder requirement of the region.
- Primary processing of perishable commodities in a cluster area of production and development of infrastructure for value chain of niche crops.
- Production of superior germplasms/ improved varieties through large-scale propagation of artificial insemination in pig and goats at the farmers' doorstep.
- Promotion of small-scale rural entrepreneurship development in pig, poultry and dairy.
- Strengthening of bio-security measures with special reference to transboundary and infectious diseases.
- Research priority on Anti Microbial Resistance (AMR) in microbes and creating awareness about AMR among farmers and farm women.

Cuttack Chapter

A one day workshop on "Climate change, biodiversity and conservation agriculture in relation to rice" was organized by National Academy of Agricultural Sciences (NAAS), Bhubaneswar-Cuttack Chapter in collaboration with ICAR-National Rice Research Institute (NRRI), Cuttack on 24th August 2018.

Distinguished NAAS-Fellows and renowned scientists and officials were present in the workshop, namely; Dr D. P. Roy, Dr P. Das, Dr T. K. Adhya, Dr H. Pathak, Dr S. K. Pradhan, Dr P. K. Sahoo, Dr P. Bhattacharyya, Dr P. Swain (Head CPB, NRRI), Dr M. J. Baig (Pr. Scientist, NRRI), Mr Anil Mistry (Regional Director, WPSI, Sundarban, WB).

Dr T. K. Adhya delivered lecture on "Climate change and microbial diversity". The Social worker and Regional Director, WPSI, Sundarban, WB, Mr Anil Mistry delivered his talk on "Conservation of forest biodiversity in Sundarban: challenges and opportunities". Dr P. K. Sahoo, a distinguished fellow of the academy enlightened the gathering on the theme "climate change, fish diseases and fish diversity threats". Dr Himanshu Pathak, distinguished Fellow of the academy and convener of this chapter, delivered a lecture on "Climate change and rice". Dr S. K. Pradhan sensitized the audience about varietal development on climate change scenario and future challenges.

The NAAS, BBSR-Cuttack chapter also organized a brain storming session on "Possibilities and potentialities of converting rice-fallow to rice-pulse system in Eastern India". The discussion initiated by Dr B. B. Panda (Pr. Sc., Agronomy), working in cropping system approach. There were thoughtful and well interacted session and few important points emerged from the discussion, which are listed as:

i) An urgent need to zonation of area suitable for rice-fallow, based on water availability, resource availability, climate change vulnerability in Eastern India.

ii) Improved and less water required pulse varieties may be considered to the potent rice-pulse areas.

iii) Ecology wise varietal selection and water harvesting/ management strategy is the key to convert potential rice-fallow areas to rice-pulse cropping sequence.

iv) The proportion of area rice-fallow (potential) which would be proposed for rice-pulse must consider local market demand and procurement transparency. Suitable MSP for specific pulses may be introduced depending on region specific condition for boosting the conversion from potential rice-fallow to rice -pulse in Eastern India.

Kolkata Chapter

Like previous years, the World Soil Day was celebrated by the Kolkata Chapter of the National Academy of Agricultural Sciences in collaboration with Bidhan Chandra Krishi Viswavidyalaya, Dhaanya Ganga Krishi Vigyan Kendra and Ramakrishna Mission Asharam at Sargachi, Murshidabad on December 5, 2018. The slogan was "Cholo Jai Mati Ke Bachai – let us join to save soil". The day long celebration was started with a 'Prabhat Pheri' with participation of about 500 farmers from the adjoining villages of the Asharam. During the procession, colorful placards, posters, slogans were displayed to sensitize farmers about the importance of healthy soil and moral of celebrating the World Soil Day. After the Prabhat Pheri participants were assembled in an auditorium for an interaction session with experts from agricultural university and line Departments of State Government. A poster session was also arranged for the occasion where 25 Ph.D. students from the Department of Agricultural Chemistry and Soil Science of Bidhan Chandra Krishi Viswavidyalaya displayed 25 posters on the theme of soil and its sustainable management. About 300 school students from adjoining seven schools were also participated in drawing (for students up to class eight standard) and essay writing (for class nine to twelve standard) competitions on the theme of the celebration and the best performers from each school and event were

awarded with prizes. A number of distinguished personalities viz., Swami Vishwamayananda, Secretary, Ramakrishna Mission Ashrama, Sargachi, Mosaraf Hussain, Sabhadhipati, Zilla Parishad, Murshidabad District, Prof Ashim Sinha, former Vice-Chancellor, Uttar Banga Krishi Viswavidyalaya, Coochbehar, Prof Srikanta Das, Dean, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur and many others including Professor Biswapati Mandal, Convenor, NAAS, Kolkata Chapter graced the celebration. All India Radio, Murshidabad district aired the whole programme for the benefit of farmers of the locality.

Academy's Collaboration with Other Major Events

Reshaping Agricultural Education

The National Academy of Agricultural Science (NAAS) collaborated with the Indian Agricultural Universities Association (IAUA) in organizing the IAUA Golden Jubilee International Conference on "Agricultural Education Sharing Global Experience" during November 23-25, 2018. Our alliance was essentially to enrich the academic legitimacy of the Conference. The Conference reiterated that education, research and extension systems, particularly in agriculture and food systems, have been instrumental globally in bringing transformational changes in a dynamic mode to ensure livelihood security for all for all times. It was highlighted that in India State Agricultural Universities (SAUs) and Deemed Agricultural Universities, as a part of the National Agricultural Research, Education and Extension System (NARES), had contributed significantly to usher in the Green Revolution, followed by White, Yellow, and Blue Revolutions. Similar developments had taken place in China, Brazil and other developing countries.

In view of the persisting high hunger, undernutrition, poverty and inequity, escalating demand for quality food, stagnating and low total factor productivity (TFP) growth, the shrinking land, water, and biodiversity resources, and the proverbial uncertainties of the fast changing climate and volatile markets, the Conference emphasized that the global educational system must be sensitive to these trends. Integrated system approach, non-splitting of agricultural universities, enrichment of agriculture through the inclusion of basic sciences, quality assurance and accreditation, governance and adequate financial support to and investment in agricultural education system should be adopted towards transforming agriculture.

The Conference recommended that the educational system should undertake business unusual to achieve (i) sustainable intensification and diversification of production and zero waste to meet demand for nutrition and food quantity and quality, (ii) 100 percent increase in smallholder productivity and income; ensuring desired profitability, social justice, and attractiveness to agriculture as a profession, (iii) ecosystem services that improve water quality and quantity, soil health, carbon capture, and biodiversity, and (iv) rendering agriculture attractive to the youth.

Fellows Views

Urban farming: An opportunity for those who wish to get out of traditional farming

With increasing population, the greatest challenge for the current Indian agriculture is to reduce the number of people dependent on traditional farming for their livelihood. In none of the developed countries more than five percent of the population is engaged in farming; it is less than two percent in USA. In India the greatest challenge of the current Indian agriculture is to reduce the number of people dependent on farming for their livelihood. India cannot be an acceptation to this global reality, if poverty is to be reduced. Worldwide, there is a trend for migration of rural population to work in industries or services in the urban areas. Global urban population is expected to reach 5.2 billion in 2050 from 2.6 billion in 2010. Currently, creation of gainful employment opportunities for the increasing population remains the priority (major problem) in the country. In the absence of jobs, migrant rely mainly on construction labor work in unorganized sector.

Rural production in processing of vegetables, fruits, milk and milk products, for value addition, have been implemented in the past, with limited success, except for milk. Urban farming, that claims large success in the developed world, provides an opportunity, for higher income and better life for rural farmers who wish give up traditional farming. Urban farming comes in various forms and complexities ranging from improved kitchen gardens in terraces to fully automated soil less cultivation, where nutrients are provided through hydroponic systems, under controlled environment, illuminated by LED lights in poly houses at the other. Vertical stacks provide additional space for growing crops in multiple layers. Modified shipping containers, stacked one above the other, are used for providing moveable, urban farms. Demand for locally grown food items, and reduction in the food miles (miles the food travels for reaching the consumer, and the energy used in transport) has further supported urban farming. Such farms have been established in the basement of multistory buildings housing restaurants, ensuring fresh supply of greens. Netherlands remains the largest exporter of glass house grown tomatoes.

Urban farming is not an area of research. Innovative ideas, considering specific local needs, by the entrepreneurs that are economically viable are necessary for success. Business model and economic viability of the urban ventures would be the key to success.

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Doubling Farmers Income through Integrated Agri-aquaculture Systems and Agri-Market Revolution

Climate change in the coming decades is the major constraint for crop production, which is expected to affect the farmers severely. Furthermore, land degradation and the degrading quality of soil, water and related environment, due to adverse effects of climate change can hinder growth of agricultural sector. Abiotic stresses like temperature (heat, cold, frost), water (drought, flooding/hypoxia), and edaphic (salinity, acidity, alkalinity/sodicity, nutrient deficiency, low organic matter content, shallow basaltic soils, soil moisture deficit, water logging, and chemical pollutants, and poor water quality) have gradually increased, which are the major limitations to food production in crops, horticulture, livestock and fishes. In addition, biotic stresses like pests (weeds, insects, pathogens of viral, bacterial, fungal, prions and parasitic origin) account for losses in crop productivity in India.

Field and horticulture crops, dairy, goatery, poultry and fisheries can be practiced in abundance, which can fuel the economy of the rural areas. Integrated Agri-aquaculture Systems (IAAS) are usually family based farming systems, involving synergies among farm enterprises such as aquaculture, agriculture and house-hold, which need to be promoted for ensuring higher food production, environmental conservation and food security. IAAS is reasonably based on the zero-budget agriculture, with the advantages of using animal manure, crop by-products, pond sediments and aquaculture wastewater as pond fertilizer, and supplementary feed for fish, fertilizers and irrigation for crop plants respectively. Therefore, diversification and improvement of agricultural production along with household based other off-farm activities such as backyard farming / kitchen gardening supported by technological innovations should be the strategy to improve the livelihoods in rural areas. Agricultural research and development (R&D) in India has made significant contribution in the past. Technological innovation has a key role to play in increasing agricultural production and strengthening food security. Improved technology interventions in IAAS for livelihood improvement of farmers should be conceptualized with the following objectives:-

1. Characterizing and upgrading existing farming systems through assessing the effect of climate change, abiotic and biotic stresses on the production and developing suitable adaptation strategies.
2. Disseminating agricultural diversification through improved technology interventions in major field crops, horticulture crops, livestock, poultry, and fisheries and integrated IAAS.
3. Enhancing livelihood and nutritional security in rural areas through introduction of suitable crop varieties/ animals breeds/fish species and dissemination of suitable production technologies within the rural farming/ social system.
4. Developing household based other off-farm activities including backyard farming / kitchen gardening supported by technological innovations through value addition for income diversification.
5. Managing abiotic and biotic stresses in IAAS through Innovation in Integrated nutrient management, Integrated pest management, Soil health assessment based fertilizers recommendation in field and horticulture crops, Disease management in dairy and goatery, Mitigation of multiple stresses including soil and water quality management in aquaculture.
6. Organizing training programmes / exposure visits / field day / workshops related to improved technology interventions in Crop-Livestock-Poultry-Fisheries and IAAS.

Fisheries holds the key for enhancing livelihood of farmers and should be promoted as an allied activity to agriculture. In our Country, there is a vast potential of reservoirs and wetlands for enhancing fish production and meeting nutritional requirement. Currently, there are some 19,370 reservoirs in India spread over 15 states with a total water surface area of approximately 31,53,366 ha. Indian reservoirs (large, medium, small) and floodplain wetlands have estimated fish production potential of 100, 250, 500, and 2500 kg/ha/yr respectively. Selected reservoirs and wetlands may be suitably used by giving major emphasis on improved technologies interventions in abiotic and biotic stress management, environmental enhancement, stock enhancement/stock replenishment of promising indigenous fish species, environmentally sound enclosure culture technologies, integrated multi-trophic culture, as yet another bioremediation strategies for enhancing fish production, which would help in achieving estimated production potential of reservoirs and wetlands. Since the 1960s, India has seen the Green revolution, White Revolution, Yellow revolution and the Blue Revolution. Rainbow revolution holds the key for all-round Indian agriculture growth, by shifting towards other allied sectors of Indian agriculture and focusing on income security of the farmers. To reach its full potential, Indian agriculture urgently needs another

revolution i.e. Agri-market revolution. Advancement in information technology, sustainable cold chain connecting farms to cities, direct marketing of the food grains, fruits, vegetables, milk, and fish from farm to consumer will help farmers to develop entrepreneurial agri-businesses. We need to focus more on making strategies for revolutionizing the agricultural market, enhancing the livelihood of resource poor farmers in our Country, which may help achieving Hon'ble Prime Minister's target of doubling farmers' incomes by 2022.

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Forthcoming Programmes for 2019

1. Strategy Workshop on "Uniform Policy for Fish Disease Diagnosis and Quarantine"; Convener: Dr P. K. Sahoo
2. Brainstorming Session on "Enhancing Science Culture in Agricultural Institutions" ; Convener: Dr N .H. Rao
3. Brainstorming Session "Payment of Ecosystem Services"; Convener: Dr P.S. Birthal
4. Brainstorming Session "Vertical Farming"; Convener: Dr Bramha Singh
5. Brainstorming Session "Big Data Analytics"; Convener: Dr Rajender Parsad
6. Brainstorming Session "Potential of Non-bovine Milk"; Convener: Dr M. S. Chauhan and Dr Ashish Kumar Singh

Announcements

XIV Agricultural Science Congress

The XIV Agricultural Science Congress of NAAS on "Innovations for Agricultural Transformation" scheduled during February 20-23, 2019, announced in the past three volumes of this Newsletter, is a Congress with a difference. The theme of the Congress, "Innovations for Agricultural Transformation" is not only central to the national complementary pledges of building a New India and Doubling Farmers' Income by 2022, but it also promotes disruptive innovations for transforming agriculture and food systems to reshape India. The Congress will showcase agriculture not only as the main source of employment and livelihood security for nearly 50 percent of India's population, but also as a business opportunity, service provider, industry promoter, and an ecosystem protector.

The other uniqueness of this National Congress is that it will contextualize "World Grant" approach to share successful global experiences to empower the scientific community and other stakeholders to liberate the humanity of chronic deprivations. Besides our own renowned Indian science leaders, nearly 20 leading scientists from abroad and international organizations will be delivering Lead Lectures under the various sub-themes.

Election of Fellows and Selection of Associates

Nominations are invited for Election of Fellows and selection of Associates of the Academy for the year 2020. The last date of receipt of Nominations is March 31, 2019. Nominations forms are available at website: http://www.naasindia.org.

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