Grand challenges in plant sciences

According to the sustainable development goal of United Nations, the grand challenges in the coming years will be related to food and feed supply, human nutrition, energy, medicine, environmental sustainability and much more[1]. The agricultural sector should contribute to food security and sustainable agriculture, focusing on nutritionally improved crops, promoting sustainable use of terrestrial ecosystems and saving biodiversity[1]. To meet these challenges, significant contributions from plant sciences are required. Based on several reports, research focusing on plant resilience, genotype-to-phenotype, data science, systems biology, biosensing, synthetic biology, neural networks, robustness, interdisciplinary training, new tool development, modelling, staple food crops of high yield and minor crops which increase agricultural diversity and human nutrition, energy crops with efficient energy conversion and resilience to climate variability, etc. is needed. The growing human population and pressing environmental challenges have forced us to think about future economies which will be plant-based. Hence, it is necessary to reimagine research on plant sciences as a critical component of fundamental science (including plant ecology), agriculture, energy, technology and healthcare. The current challenge of plant sciences is understanding the huge amount of data generated to solve real problems. After the genomic and post-genome era, during the late half of the 20th century, the digital revolution started and is progressing rapidly. This emerging technology needs to be used for plant research.

As mentioned above, the future economies will be plant-based. For example, plant biomass is projected to be a major source of primary energy by 2050, plant-based meat and dairy products are transforming the food industry[2,3], and plant-based vaccines against several diseases are increasingly being researched. To meet the demands of the future economy, we need to strengthen plant sciences, attract talent and train the next generation of plant scientists. The initiative needs to be taken to bring together scientists and engineers from a wide range of fields to solve fundamental problems in plant biology with innovative solutions from emerging technologies. There is growing evidence to indicate the increasing expectations of expanding economies that plant sciences can offer that a lot of things depend on the research of plant sciences. Keeping this in consideration, experts of PAC of OEB – Plant Sciences of SERB conducted several rounds of discussions. Since plant biology is a key area of science involved in ongoing and future efforts to combat the consequences of global warming, climate change, pollution and population growth, there is a need to have a focused discussion on the following important areas:

• Basic plant biology research to address food and nutrition security.
• Land-use change and biodiversity loss.
• Climate change adaptation and mitigation.
• Divergent paradigms for the future of agriculture.
• Crop models and 'forgotten' crops.
• Natural forest ecosystems.
• Heat waves and marine biology.
• Photobiology.
• Data analytics.
• Data quality.
• Artificial intelligence, satellite remote sensing, serial image processing, big data, knowledge graph and other technologies.

Research support is required on the following:

(1) Plant resource conservation: Research institutions should have state-of-the-art seed/germplasm/plant growth-promoting rhizobacteria preservation facilities.
(2) Capacity building: Institutions should have plant molecular biology and bioinformatics teams to support omics data analysis and experts on image processing.
(3) Interdisciplinary research: Institutions should encourage collaborative research in soil, microbiology and atmospheric science.

To effectively cope with the grand challenges, Plant Science Programme Advisory Committee discussed some broad questions (given below) to formulate actual scientific question with the consensus of the plant sciences community of the country.

(1) What should be the focused areas of plant sciences research in view of current and future scenarios?
(2) How can we mitigate global climate change and design sustainable research in plant sciences?
(3) How can the community enable plant sciences research to maximize its value and impact over the next 20 years?
(4) What should be viable new models for interdisciplinary collaboration facilitated by Information and Communication Technology and data analytics that allow meaningful participation by all collaborators?
(5) How can we emphasize investigations on basic information in plant biology?
(6) How to develop policies to encourage public–private partnerships, especially in transferring advanced artificial intelligence technologies to plant and environmental sciences?
(7) What are the priority areas of plant sciences to be included in artificial intelligence research?
(8) How can we strengthen the plant sciences outreach programmes and tailor them to meet specific contextual challenges?

In recent years, a rapid change has been noted in the diversity of flora and fauna. While focusing on ecosystem conservation, it is important to meet the global demand for plant products for which a robust fundamental understanding of plant biology with the environment and translation of this knowledge into field-based solutions is needed. Due to the rapid and continuous development of science and technology, there is a need to evolve interdisciplinary subjects and activities. The PAC of OEB – Plant Sciences proposes to gather opinions and feedback from experts in the plant sciences community to develop concept notes and action plans. This effort is expected to help conserve the ecosystem and enhance the capacity of the agri-cultural system sustainably.

1. https://sdgs.un.org/goals
2. Reid, W. V., Ali, M. K. and Field, C. B., *Global Change Biol*., 2020, **26**, 274–286.
3. Shepon, A., Eshel, G., Noor, E. and Milo, R., *Proc. Natl. Acad. Sci. USA*, 2018, **115**, 3804–3809.

Shilpi Paul*, Neelima Mishra and **Dipti Kakkar Thukral,** Science and Engineering Research Board (a Statutory Body of the Department of Science and Technology, Government of India, New Delhi 110 016, India.
*e-mail: shilpipaul@serb.gov.in