

# **Plant Factory for Next generation Towards Sustainable Smart Plant Factories with LEDs, Artificial Intelligence and Phenotyping**

Toyoki Kozai  
Japan Plant Factory Association, Kashiwa-no-ha, Kashiwa, Chiba 277-0882, Japan

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## **Abstract**

More and more people are thinking recently that plant factory with artificial lighting (called PFAL hereafter) will contribute to solving the trilemma on foods, resources and environments. In commercial plant factories with artificial lighting (PFALs) or indoor farms, it is important to find optimal set-point combinations of environmental factors at each growth stage to maximize the yield, quality and/or economic value with minimum resource consumption, waste production and cost. This complexity of environmental control provides an opportunity to develop ‘smart’ PFALs using light emitting diodes (LEDs), artificial intelligence (AI) with big data mining, information and communication technology (ICT), modeling of energy/mass balance and plant growth, and phenotyping using camera image sensing of plant traits. In this presentation, ideas are provided regarding smart LED lighting systems, a dual PFAL and a cultivation system module for scalable PFALs, which enable commercial production, large-scale experiments and plant breeding to be conducted concurrently. ‘Smart’ means, in this paper, intelligent, resource-efficient with minimum waste, compact, inexpensive, easy-to-use, and so forth. Among many environmental factors, light is the most important and it has various aspects. The application of LEDs as a light source for PFALs has attracted increasing attention. LEDs are used not only to enhance plant photosynthesis and control photomorphogenesis, but also to increase secondary metabolite production, raise the disease resistance of plants and control populations of pest insects and microorganisms. Concepts and a methodology on how to integrate the recent advanced technologies mentioned above to develop the next generation of smart PFALs are discussed.

**Keywords:** artificial intelligence (AI), big data, light emitting diodes (LEDs), phenotyping

## **References**

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