Chapter 1

Introductory Chapter: Plant Engineering for the Future Ahead

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Additional information is available at the end of the chapter

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1. Time to choose the right path

Earth today is experiencing visible climate changes, the one battle for which the humans are still not prepared enough to win. Existing economic, social, and cultural discrepancies between developing and developed countries are a constant obstacle for the "way forward," and the decisions about environment, food, and education brought today will influence our children tomorrow. This book is intended for those who still believe that our greatest strength is actually our curiosity. Basic research scientists worldwide are constantly struggling to obtain enough, mostly public, funds to provide sound foundations for innovations in all aspects of life; however, the pressure to publish first occasionally neglects the fact that every creative idea needs a considerable amount of time to be realized, often with negative results. Although the criticism in science is always welcomed, whether it comes from the fellow scientists or from the public voice, due to the lack of understanding, the complicated problems we are trying to solve become even more difficult. For example, if tomorrow the bacterium *Xylella fastidiosa*, outlined by Alyson Abbott in Nature (8 June 2017) as a huge problem for the olive groves in Southern Italy, spread to the rest of Europe, the only measure would be to uproot the contaminated plants. Although the infection could have been stopped/decelerated years ago, environmentalists challenged scientific findings and fight against contaminated olive plants uprooting. Italy has already allocated more than 5 million euros for the containment measures and will be forced to increase the funding in the future. We should ask ourselves, "Could we rely on science to find a more creative solution?"

2. Brief introduction to the chapters

The first chapter in the book is dedicated exactly to the problem of plant defence mechanisms against pathogens. According to the Food and Agriculture Organization of the United

Nations (FAO), each year between 20 and 40% world crop yields are lost due to the pathogens. One of the innovative tactics would be to explore the impact of the small RNA molecules on the plant-microbe interactions. Balmer et al. traveled beyond the well-documented antibacterial responses and concentrated on a hemibiotrophic fungus *Colletotrichum graminicola* that is detrimental for one of the most important world cereals, maize. In 1970, severe anthracnose epidemics eradicated the production of sweet corn in Indiana, USA. Disease was reported almost worldwide, with the yield loss ranging from 0 to 40%. Research on plant-microbe communication might help us to combat some of the worst pathogen-related crop diseases nowadays. Modulation of gene expression could be achieved by the usage of otherwise damaging gamma-rays, also. Beyaz and Yildiz exploited the power of gamma-irradiation to create new plant mutants with elevated amounts of antioxidant enzymes and proline. Although not novel, this technique is slowly showing its value as many countries express negative attitudes toward genetically modified foods (GMOs). One of the appealing strategies to increase the plant yield would be to obtain the control over the timing of flowering. FAO estimates that around 800 million people are currently undernourished. The food distribution and security throughout the globe is uneven and largely at risk due to the unpredicted weather events, extreme climate changes, diseases caused by pathogenic microbes, as well as abiotic diseases, and political perturbations. Flowering, as one of the fundamental processes in plants, has largely been investigated at the genetic level in the model plant Arabidopsis. Nevertheless, the number of reports on economically important plant species is steadily increasing, giving us the tool to artificially modulate the timing of transition from vegetative to reproductive plant stage. In that sense, Purwestri et al. identified the proteins that are able to interact with the protein responsible for the transition from vegetative to reproductive phase, the Flowering Locus T (FT), in rice. According to the International Rice Research Institute (IRRI), more than half of the 7 billion people on the planet consume rice as the staple food. Kasajima et al. demonstrated an interesting approach to accelerate the flowering time by introducing the Apple latent spherical virus vector in a number of plant species; again, an interesting approach to circumvent the bad reputation toward GMOs. Not only the food availability but also its usability could be improved. In the third chapter, genetic transformation of the sorghum plant led Elkonin et al. to improve the nutritional value of this highly important crop. Mazur and Friml investigated in great detail vascular tissue development and regeneration in Arabidopsis. This knowledge would be beneficial in the future tree investigations. Finally, the fourth chapter deals with the constant efforts of the scientific community to predict and battle the unfavorable living conditions on Earth. Nagargade et al. discuss about the strategies to develop the climate-resilient agriculture. One of the approaches for increased yield would be to "teach" the greenhouses to constantly change the parameters in order to achieve the optimal growing conditions for the given plant species, as described by Shamshiri et al.

All the strategies described in this book represent a small, but valuable contribution of the plant scientific community to decrease the yield losses, improve the food nutritional values, and make it safer for consumption. Only through the joint effort and the constant collaboration between the scientists, farmers, and distributers, we could gain the consumers' trust and implement the smart managing over the Earth resources.

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