PREFACE

Transgenic plants constitute an extraordinary chapter of the History of Science and Technology. As mentioned by Léon Otten in Chapter 2 of this volume, Mary-Dell Chilton (Washington University), Jeff Schell and Marc van Montagu (University of Ghent and Max Planck Institute for Plant Breeding in Cologne), and Rob Horsch (Monsanto) independently reported on the transfer and expression of a marker gene in tobacco plants at a Symposium in Miami in 1983. Transgenic plants were officially born! These achievements owe a lot to the long history of studies on bacteria from the genus Agrobacterium, which perform natural genetic engineering. This fascinating history is also included in Chapter 2.

Since then, transgenesis has become a major tool for plant biologists. And it still is for the more recent developments known as 'gene editing' which often requires transgenesis for transferring the editing tools into plants.

Transgenesis is viewed by many scientists as a crucial tool for modern plant breeding. Actually, this volume goes further back, to the invention of agriculture which would not have been without plant domestication, which in turn was dependent on genetic modification in a broad sense. Thus, in Chapter 1, Henry Miller and Piero Morandini argue that crop genetic engineering resulted in improved domestication traits.

Highly promising applications for human health, namely, the production of recombinant therapeutic molecules in plants, have also been developed using various plant-based expression systems, as detailed in Chapter 7 by Qiang Chen.

This volume is also about innovations beyond transgenesis: gene editing, as mentioned above (see Chapter 8 by Maxence Pfeiffer, Francis Quétier and Agnès Ricroch), and also epigenetics. In Chapter 9, Aliki Kapazoglou, Ioannis Ganopoulos, Eleni Tani and Athanasios Tsaftaris take us in the world of epigenetics, its regulatory role during plant development, its involvement in environmental stress tolerance and hybrid vigour, not forgetting graft-induced epigenetic changes. This chapter also discusses how epigenetics can be a source of phenotypic variation for plant breeding. It presents the main experimental techniques for DNA methylation profiling in plants and future trends such as third-generation sequencing.

Transgenic plants are not only about science and innovation. In 1990, the European Union legally defined the concept of 'genetic modification'

in a Directive. This Directive first listed all existing genetic modification techniques, but then exempted them all from regulation apart from the most recent one, transgenesis. This has had enormous consequences worldwide regarding the use of biotechnology in agriculture. In this context, Arujanan Mahaletchumy and Paul P.S. Teng explain in Chapter 3 the legal, regulatory and labelling status of biotech crops.

This legal concept of 'genetically modified organisms' (GMO) has been adopted by many countries around the world and has triggered heavy regulation, and sometimes bans. Thus, the future of gene editing is strongly dependent on whether these 'edited' organisms will fall, or not, within this legal concept of 'GMO' as discussed in Chapter 8.

As another consequence of regulation, in most countries, transgenic plants are subjected to mandatory risk assessments before marketing is allowed. In Chapter 4, Andrew Bartholomaeus presents the basic principles of ethical regulation and the plausible risks borne by plant genetic modifications which need to be tested for food/feed safety. This chapter also warns against the damaging consequences of the current regulatory rules applied in a number of jurisdictions. Recombinant DNA technology applied to plants has actually been subjected to an impressive amount of risk assessment studies, both from industries seeking marketing authorization and from public laboratories, regarding the environmental impacts of these plants. In Chapter 5, as an emblematic case for nontarget organisms, Agnès Ricroch, Serife Akkoyunlu, Jacqueline Martin-Laffon and Marcel Kuntz summarize the risk assessment studies performed on honeybees.

As a case study for developing countries, the needs for genetic engineering of crop plants in Colombia are explained by Julián Mora-Oberlaender, Adriana Castaño Hernández, Silvio Alejandro López-Pazos and Alejandro Chaparro-Giraldo in Chapter 6. This country has taken the challenge of developing technical and institutional capacities to ensure the safe use of transgenic crops, and its experience could be highly valuable for many other countries. This chapter also gives advice on how to perform a 'Freedom to Operate Analysis' in order to increase the chance of bringing a product to the market despite a heavily regulated and patented landscape.

This volume would not have been complete without asking the question 'Why products, although highly diverse, just because they fall into the "GMO" classification, have struck a powerful emotion called fear?' Nayla Farouki analyses this phenomenon in Chapter 10 and the consequences of decades of politicization of the scientific domain.

I believe this volume will be highly useful to researchers but also to students and teachers (many of its illustrations will come in handy for teachers), as well as science journalists and regulators, especially in countries wishing to develop or improve existing biosafety regulations. Most chapters contain valuable Internet links to regulatory articles, international agreements or GMO databases.

Finally, I would like to thank all the authors and contributors who made it possible to produce this volume.

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