Genetic Glass Ceilings: Transgenics for Crop Biodiversity

Jonathan Gressel

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The term 'glass ceiling' was first coined in the mid-1980s to characterise an artificial upper limit on women's careers. Below the glass ceiling, room for advancement is tantalisingly visible, but the situation makes crossing the barrier impossible. In the context of this book, Jonathan Gressel explains another glass ceiling, one established by the inherited genomes of food, fibre, and medicinal plants, and perpetuated by the constraints of classical plant breeding.

A molecular biologist and Professor Emeritus in the Department of Plant Sciences at the Weizmann Institute of Science in Rehovot, Israel, Gressel makes clear how molecular biology and transgenics can overcome these constraints, and enable the sort of progress which is otherwise out of reach.

Gressel divides his book into two major sets of chapters.

Chapters 1–9 establish the stubbornness of the genetic glass ceiling. Gressel explains that the genomes of the plants upon which we rely for our food, fibre, and, increasingly, medicines and fuel, do not have within them the genetic diversity required to enable the necessary improvements. The genes needed to sufficiently increase their productivity, or to allow them to withstand many biotic (eg diseases, pests) and abiotic (eg drought, floods) stresses, simply aren't there. If the world is to have both an adequate supply and a desirable quality of what we harvest from crops – while maintaining uncultivated and wild landscapes – the crops must be further domesticated and improved. Gressel explains carefully and in detail how to achieve these important goals, using transgenics and the intricate tools of molecular biology.

Chapters 6 and 7 powerfully convey the importance Gressel assigns to overcoming the current barriers to agricultural progress, by describing the misfortunes that plague the status quo.

Chapter 6, titled, 'Evil Weevils or Us: Who Gets to Eat the Grain?' addresses the significant losses that farmers, especially poor farmers in developing countries, experience when weevils infest their crops and harvests. These losses deal a crushing blow, typically destroying between 40 and 60 per cent of the yield. Gressel discusses how farmers currently deal with weevils, if they deal with them at all, and proposes biotechnological solutions that could be far safer and more effective.

In the following chapter, 'Kwashiorkor, Diseases, and Cancer: Needed: Food without Mycotoxins', Gressel explores the impacts of mycotoxins upon human health and life

expectancy, with an emphasis on the poor in developing nations. He presents evidence that mycotoxins, over short terms at high levels, or over lifetimes at low levels, are widely responsible for disease and premature death. Misery on such a scale is unnecessary, he says, since the developed world has the money and the technology to deal with these carcinogenic toxins. The poor in developing nations have no access to either, and for Gressel, the answer is plant molecular biology and transgenesis.

Chapters 10–23 comprise the second major set of chapters. In each of these 14 chapters, Gressel provides an exacting analysis of the genetic limitations of a specific, and often underutilised, crop. Chapter by chapter, he describes the glass ceiling which prevents further development of papaya, oil palms, rice, tef, buckwheat, sorghum, oilseed rape, safflower, fonio millet and pearl millet, grass pea, yam, tomato, olives, and – the only horticultural crop highlighted – orchids. In each chapter, he describes the biotechnological solutions which exist, or are being developed, to overcome the crop's inherent limitations.

While these crop-specific chapters abundantly display Gressel's vast knowledge of genetics, molecular biology, agronomy, and plant breeding, his approach engages the reader with the style of a mystery novel. Each presents a set of genetic puzzles, or surprising and unexpected molecular events, which in the end are deftly resolved with an insight worthy of Sherlock Holmes. Although his chapters are dense with scientific knowledge and the scientific method, they are nonetheless riveting for those who can feel the excitement of scientific exploration and the joy of discovery.

Typical of Gressel's approach in the crop-specific chapters is the 15th, titled, 'Should Sorghum Be a Crop for the Birds and Witches?' He begins by explaining two seemingly intractable problems faced by African farmers who plant sorghum: the birds that devour the grain while it stands in the field, and the weeds (one called witch weed) that interbreed with or are parasitic to sorghum. After describing the years of breeding and agronomic research that have been devoted to solving the bird and weed problems, he presents the case for biotechnological solutions. To deal with the birds, Gressel proposes that sorghum be redesigned so that its grain head is protected by the same sort of enclosure that protects the ears of maize. For the weeds, Gressel points out that sorghum can be made herbicide-resistant, enabling farmers to control weeds without harming the crop itself.

Gressel is persistently mindful of the environmental effects that his proposals might entail, and for these, he describes strategies to avoid, reduce, or manage these effects. His environmental protection strategies also involve the use of biotechnology, and results impossible to achieve through conventional breeding techniques.

Like the Foreword, by Klaus Ammann, Gressel's Epilogue is a passionate and heart-felt essay on the benefits that plant sciences – especially molecular biology and transgenics – offer for the preservation of biodiversity and the development of rational policies relating to the human endeavour of agriculture.

Everyone who wants to learn and understand more about plant breeding and agricultural biotechnology should read Jonathan Gressel's book. Its wealth of erudition and wisdom makes it worthy of recognition as a modern classic.

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