engineering with multiple genes, where problems arising from gene silencing from repeated features of the construct are feared. However, in a recent case of 'who dares, wins', transgenic *Brassica* plants enriched in polyunsaturated fatty acids were generated through incorporating nine different transgenes, expressed on a single construct from multiple napin promoters [1].

In spite of the millions of acres of transgenic crops now grown in many different countries, improved traits are still limited primarily to resistance to herbicides and insects conditioned by a handful of transgenes. These technologies were already developed and their impacts being actively debated back in 1996. This year saw regulatory approval for growing herbicide-tolerant alfalfa in the USA, an event that might have an important impact on the future of transgenic crops. Alfalfa is one of the world's major forage legumes; its approval opens the door for pyramiding additional new transgenic traits that impact on forage quality, animal nutrition and environmental quality. Successful introduction of nutritionally improved forage crops could help to 'bridge the gap', from a public perception standpoint, between input traits such as herbicide tolerance and the ultimate output trait of nutritionally enhanced human food. Time will tell!

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Plant functional genomics: beyond the parts list

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Although one might infer something about how a supersonic jet aircraft flies by identifying all its parts, it would help to know how all the parts fit together to produce a functional machine. Now that two plant genomes have been fully sequenced, and many genes have been identified for other plant species, we are in the midst of understanding how all the parts interact to produce a plant – in other words – functional genomics. I personally have never been too enamored of simply identifying parts. As an avid British car enthusiast, I enjoy tinkering in the garage (it helps particularly to understand electrical circuits) to improve, or at least maintain, an old automobile. Identifying a bunch of parts on the garage floor is not as enjoyable as tinkering. Functional genomics is the fun part of the science in my view – the integrating science behind the special endowments of plants that not only endear these organisms to plant scientists but also have important roles in feeding the world.

The four functional genomics papers in this special tenth anniversary issue of *Trends in Plant Science* illustrate the globalization and increasing accessibility of the science, which is a fairly recent development in its own right. Unlike high-energy physics, which has always been and always will be expensive, the cost of genomics research has decreased [1]. It should not be surprising to see it being used for crop improvement to help feed the world's poorer people, the theme of this issue of *Trends in Plant Science*.

In this issue, Willem Rensink and Robin Buell focus on expression profiling as a functional genomics tool. In microarrays, we see a classic case of gradual affordability. Over the past 7 years, the cost of doing a microarray experiment has decreased by an order of magnitude, whereas the information on an array has increased threefold, at least for *Arabidopsis thaliana*, making this technique much more accessible to the typical researcher. Along with the initial high costs, there were also fears that microarray experiments would not be replicable, but recently it has been shown that the data are fairly robust; not perfect, but not as problematic as originally predicted [2].

Rice is perhaps the most important crop on earth, and in this issue Yonghong Wang *et al.* shine a light into China to discuss how scientists there are using biotechnology and genomics to improve this staple crop. The modest size of the rice genome is advantageous and the resources available are tremendous. One aspect of these resources, not exclusive to rice of course, is the burgeoning of databases interconnected via the internet. Indeed, it would be difficult to imagine genomics without the internet, which has greatly increased the utility of bioinformatics to the practicing geneticist – particularly in developing countries.

One condition that continues to plague mankind, particularly some of its poorest members, is soil salinity. Here, Toshio Yamaguchi and Eduardo Blumwald describe research progress towards the production of salt-tolerant plants. Specifically, marker-assisted breeding and QTL identification coupled with transgenic approaches are likely to provide stable solutions to an ever-growing problem. In this example, we see how functional genomics has built upon the foundation of biophysics research involving transporters and antiporters to better understand how the genome of a plant might be manipulated to increase its salt tolerance. This example shows how functional genomics 'stands on the shoulders of giants.'

Finally, we have a paper by Rajeev Varshney *et al.* on genomics-assisted breeding as a method to improve crops. They provide a list of bioinformatics resources and

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databases useful for using genomics in breeding. In addition, they go beyond marker-assisted selection to describe how gene expression data might be useful in crop breeding. In particular, they discuss the future of expression QTL (eQTL). Expression profiles can be mapped and added to the information needed to understand trait development in plants. This example illustrates the trend of *in silico* biology becoming as important as bench-top biology.

Amongst all the clatter about the post-genomic age and the waning excitement over completed genome sequencing of humans and now plants, I think the best is yet to come. We are (thankfully) passed the era where a millionaire genome guru has sequenced his own DNA, and onto an exciting time where genomics information can actually be applied to benefit agriculture and food production: egalitarian agrarian biology. Also thankfully, it is not only rich laboratories in ivory towers who are participating in the discoveries that will benefit the world. Indeed, some of the best work is being performed in developing countries because their governments have chosen to invest in facilities and scientists in this key area of functional genomics. The trend is pointing toward more collaboration and sharing of data and materials across national boundaries, with open source biology potentially leading the way into future discoveries. Among all the biological sciences, perhaps functional genomics and mankind have the most to gain from this trend.

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Plant biotechnology in Europe: a changing environment and landscape

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One of the biggest challenges of the 21st century will be to sustain the production of food. We must produce as much food over the next 40 years as we have during the past 10 000 years to feed a world population that is projected to rise by 3 billion over the next 40 years to ∼9 billion people. This challenge must be met without a significant increase in arable land and during a period in which we might be facing climate changes. The implementation of plant molecular breeding using modern gene technology has the potential to help to secure sufficient food production on our planet for generations to come. But the use of biotechnology is still viewed with suspicion, particularly by the European public, and heavily criticized by some non-governmental organizations (NGOs). Some of the strongest opponents of the use of molecular breeding in food production have linked gene technology with their desire to combat multinational companies. Multinational companies have pioneered the development of plant gene technology primarily to make money. Patents have protected the technology development and utilization, which has made the university scientists and companies involved in the molecular breeding of plants even more vulnerable to criticism. The first generation patents are now expiring and scientists in the public sector, as well as a host of smaller plant biotech companies, are now acquiring patents and heading new exciting developments. Europe should not miss out on the chance to play a major role in this second plant biotechnology wave.

The general public is skeptical about the new technology, which is understandable and reasonable, and does not necessarily embrace the technology and the products (e.g. genetically modified foods) derived from it. The first transgenic crops to be developed have been prototypes without direct and obvious benefits to the individual consumer. When genetically engineered plant products of direct benefit to the individual consumer become available and the general public experiences and realizes that the stipulated worst-case scenarios associated with the use of such products are not real, much unwarranted skepticism should disappear. Outside the agricultural sector, the use of gene technology has gained wide acceptance. For example, insulin produced by gene technology is used in the treatment of diabetes, and many common household products, such as washing powder enzymes and many food ingredients produced in genetically modified microorganisms, are also generally accepted.

Increased acceptance of novel technologies is dependent on other elements such as proper risk assessments, properly implemented monitoring systems, open discussions and education. In this context, acceptance of gene technology by the younger population in Denmark has improved over the past five years. The approval of two experimental kits that enable Danish high school students to produce and carry out experiments with transgenic plants in their high school class room as an integrated part of their training in biology has given students hands-on experience of plant gene technology [1] (Figure 1). At present the average Dane is not yet confident about the use of plant gene technology in agriculture. However, the

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