CellPress

Letter

The Need to Understand GMO Opposition: Reply to Couée

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Ivan Couée [1] suggests that our article 'Fatal attraction: the intuitive appeal of GMO opposition' [2] defines the societal debates about biotechnology as 'a battlefield between rationality and irrationality'. Instead, he proposes 'a framework of mutual respect and interest between citizens and scientists'. However, we believe that this is a false dilemma. While we endorse his plea for mutual understanding, we think that comprehending how concerns and beliefs about GMOs arise from untrustworthy sources facilitates, rather than impedes, the development of a conciliatory framework. In our experience, when scientists learn about the intuitive and emotive basis of public concerns, they do not put them aside as irrational. On the contrary, they tend to take a more lenient attitude towards GMO opposition, simply because they now better understand where it stems from and why it exists. Moreover, understanding GMO opposition induces scientists to consider the role and the impact of science on society at large, and to think about ways to improve the communication and relationship with the public. On the side of the public, the realization that some of their ideas are illusory prompts lay people to reconsider their stance towards GMOs.

Couée acknowledges the need to understand why people oppose GMOs. Indeed, he renders his own account, arguing that in the wake of earlier cases, people are understandably skeptical about the introduction of new biotechnologies. This rationale leads Couée to describe the opposition as a case of empirical rationality. We welcome his attempt to account for GMO opposition, which certainly has merit. We can indeed imagine that earlier cases have made citizens more cautious towards biotechnology. However, Couée's explanation for why people oppose GMOs does not make the opposition any more rational than our account in terms of human cognition. In the end, opposing GMOs in general remains unreasonable in light of the scientific evidence. This includes evidence pertaining complex societal issues, about which lay people err as much as about facts concerning the technology. Moreover, Couée's approach fails to account for the typical features of the GM opposition and why the focus lies on GMOs and not on other technologies. As such, an analysis in terms of intuitions and emotions makes an essential contribution to the understanding of GMO opposition.

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2. Blancke, S. *et al.* (2015) Fatal attraction: the intuitive appeal of GMO opposition. *Trends Plant Sci.* 20, 414–418

Forum

The Future of Field Trials in Europe: Establishing a Network Beyond Boundaries

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We propose the establishment of a European Consortium for Open Field Experimentation (ECOFE) that will allow easy access of European plant and soil scientists to experimental field stations that cover all major climatological regions. Coordination and quality control of data extraction and management systems will greatly impact on our ability to cope with grand challenges such as climate change and food security.

Technical and social infrastructures are the backbones of modern societies, enabling vital amenities such as supply and disposal of products, financial transactions, education, art, social security, and health services. Without such infrastructures, trade, travel, and technological and social progress would be almost impossible. Because they are so essential, it is commonly accepted that infrastructures are a public responsibility, in other words they are developed and maintained by the state.

Because infrastructures for scientific research are equally important for the advancement of science and technologies, governments are also assumed to be responsible for experimental and explorative infrastructures with high financial requirements, such as particle accelerators (CERN[i]), centres for space exploration, etc. For example, the Federal Government of Germany finances, among others, 20% of the CERN budget[ii] and research vessels for marine research[iii]. Similar endeavors with government support are the French national synchrotron facility SOLEIL[iv], its Italian equivalent Elettra[v], and the Dutch Foundation for Fundamental Research on Matter (FOM[vi]). The British Science and Technology Facilities Council (STFC[vii]) operates large-scale facilities including the Rutherford Appleton Laboratory, the Daresbury Laboratory, the Chilbolton Observatory, and the UK Astronomy Technology Centre. Common to these infrastructures is that they are too expensive for a single university or research institute, and that they can be used most efficiently by a cross-institutional and multidisciplinary research community. A recent example of a European environmental monitoring network is the Integrated Carbon Observation System (ICOS[viii]) which is now part of the strategic European Strategy Forum on Research Infrastructures (ESFRI) Roadmap. We feel that similar support for translational plant sciences is needed.

Field trial sites, such as experimental stations or experimental fields, are essential research infrastructures for environmentally oriented agricultural sciences including agronomy, plant breeding, crop protection, agro-ecology, and soil science. The aim is to study the interactions between cropping systems and the environment, and to learn about the performance of genetic material in natural environments. At these test sites, research questions are investigated at the level of the plot (e.g., process studies), field (e.g., productivity), farm (e.g., crop rotations) or even landscape (e.g., matter fluxes, ecosystem services). Usually these field trial sites are run by individual, national research institutions. They require substantial investments, are expensive to operate, and their purpose is therefore often questioned by financial evaluators/auditors. As a result, several agricultural experimental stations have been closed down in recent years. Well-known examples are the Long Ashton Research station, closed in 2003[ix], and the University of Bonn field research station Dikopshof, which was closed in 2009 after more than 100 years of activity[x].

A closer look at the research topics investigated at field trial sites demonstrates their irreplaceability: questions related to crop productivity and quality [1], climate change effects on crops [2,3], nutrient fluxes in agro-ecosystems, resource efficiency, stress mitigation [4], or the properties of resilient cropping systems cannot be investigated in test tubes in the laboratory. Usually they imply the interactions between genotype (G), environment (E), and management (M), in short: the G $\times$ E $\times$ M interactions [5]. Inevitably, the investigation of G $\times$ E $\times$ M interactions requires, in addition to genotypic variation, ranges of environmental factors or gradients, and variation in agronomic management. In view of a growing world population, global climate change, and increasing strictness of environmental policies, we can expect that the above-mentioned themes will gain importance in agricultural and plant research, and it is imperative to investigate whether we have the appropriate infrastructure to meet these challenges. We may reasonably assume that a deeper understanding of the effects of plant traits and production intensity on ecological processes is a necessary prerequisite for designing cropping systems that meet the demands of our society for high productivity and sustainability at the same time. As a consequence, future research in plant and agro-ecological science will increasingly depend on large-scale and long-term data obtained from scientific experiments under real-world conditions.

Individual universities and even some of the larger governmental research institutes do not have the resources to set up and maintain a set of field trial sites that would cover the relevant range of natural conditions and allow state-of-the-art monitoring and experimental variation of environmental factors including temperature, CO_2, and water. Such an infrastructure can realistically only be organized as a network. This network should comprise large parts of the relevant science community and should not stop at national borders because research problems are also not defined by such borders. Similarly to particle accelerators and research vessels, this field experimental network should be considered as a genuine governmental or, in a European context, inter-governmental task.

Such a network of field trial sites, provided with long-term funding, would give the research community the necessary administrative and financial security for long-term activities. Moreover, a network structure would allow coordinated development of the individual sites, ensuring the necessary specialization and optimal resource allocation. For example, selected sites could be equipped with technology for rain control and irrigation, some stations could operate CO_2-enrichment facilities, and others could be equipped with the safety structures necessary for work with genetically modified plants. Phenotyping platforms could be installed and even protected sites for field research on genetically modified crop plants could be part of the network. Researchers would be able to conduct their experiments at the locations most suitable for their research questions and could choose, for example, relevant gradients of soil and climatic variables. As a consequence, such a network would provide much better services than currently available and use resources more efficiently than individual field stations allocated to individual research institutions. In a network, keeping technical equipment up to date would be easier and methodological standards and quality assurance systems, which are currently largely non-existing, could be implemented. Moreover, most importantly, a network would make interdisciplinary collaboration easier, simply because the chances of finding appropriate partners are higher in a larger community.

Although 'traditional' research stations exist only in a limited number of locations, many countries operate locally distributed, official routine trial sites, for example for cultivar testing, and monitoring stations, for example to monitor water quality, at a large number of sites. These could be integrated into the envisaged network, thereby extending the geographic range and resolution of the collected information for large-scale analyses. Because these monitoring stations usually collect data-series over many years, they could contribute particularly to long-term analyses.

A network of field trial sites would not only make plant and agro-ecological research more effective, but would also open new dimensions for work on cutting-edge research topics meeting the challenges of the 21st century, which is not possible within the present infrastructure. Starting with the current situation of dispersed trial sites, an institutional framework could be initiated as an umbrella, under which the use of the experimental facilities and their development are organized. This umbrella should be a self-administrated organization of the participating universities and research institutes, and would be responsible for defining the modalities of cooperation, for example the rules for using experimental facilities, setting experimental standards, defining quality control and data utilization, and publishing results. The umbrella would also be responsible for the acquisition of funds and for the strategic development; in other words, it should set priorities for investments and define the specialization of the individual sites.

As argued above, scientific infrastructures are a genuine governmental responsibility. In the 21st century, developing plant and crop systems towards higher productivity and reduced environmental impact is clearly not only a national task; joining forces at a European level would speed up scientific progress tremendously. Moreover, a common infrastructure would also create a big stimulus for research collaboration across Europe and would have a very pronounced effect on the 'translatability' of academic plant research to more relevant field conditions. Setting up a European Consortium for Open Field Experimentation (ECOFE) therefore seems to be overdue.

ECOFE should be an organization with high standards and sufficient resources to make it attractive for existing field experiment stations to become part of the consortium, and to enable it to be much more than merely a provider of research infrastructure: it could be the forum for addressing the grand challenges of plant biological and agro-ecological research in Europe. To meet these challenges, ECOFE should also be a platform for interdisciplinary research where scientists from very different disciplines join forces to tackle the grand challenge of providing sufficient and healthy food with a minimal impact on the environment in the next decades, when the effect of climate change will be substantial.

Tightly connected with interdisciplinary, large-scale research is the use of research data. With the high expenditures in open field research, data are valuable and should be utilized efficiently by sharing them widely. This raises the question for an effective data infrastructure to make well-described, quality-controlled datasets available to the scientific community. These datasets should be made citable to create an incentive for researchers to share valuable data addressing their primary research questions. Providing the necessary data infrastructure would also be a task for ECOFE. The European Strategy Forum on Research Infrastructures (ESFIR[xi]) of the EU could also be involved in supporting this activity.

We are convinced that the time is right for an initiative as outlined above. A survey held among 30 experimental stations in Germany [6] clearly showed great willingness to collaborate more intensely. Of course there are concerns about losses of autonomy when joining a consortium, but it is the task of the consortium to demonstrate that, through collaboration, there is more to win than to lose. Because a big bureaucratic monster is certainly not attractive, a network structure with clear rules, a high degree of transparency, and a fair allocation of financial resources would be highly desirable, and regional substructures could help to minimize administrative costs.

Infrastructures for field trials including data management are a necessary prerequisite for research in plant science and agroecology. Setting up a common organization across Europe through an intelligent network of existing structures, simultaneously creating a best practice and quality control system, together with an accessible data repository, would be a major step forward in fostering a truly interdisciplinary European research arena to meet the challenges of the next decades towards food production, bio-economy, and sustainability.

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Resources

[i] http://home.cern/
[ii] www.bmbf.de/de/26379.php
[iii] www.portal-forschungsschiffe.de
[iv] www.synchrotron-soleil.fr

[v] www.elettra.trieste.it

[vi] www.fom.nl

[vii] www.stfc.ac.uk

[viii] www.icos-ri.eu/

[ix] https://en.wikipedia.org/wiki/Long_Ashton_Research_Station

[x] www.ksta.de/region/nach-105-jahren-eine-aera-geht-zu-ende,15189102,12790586.html

[xi] www.elixir-europe.org/

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