OPINION

Confronting the Gordian knot

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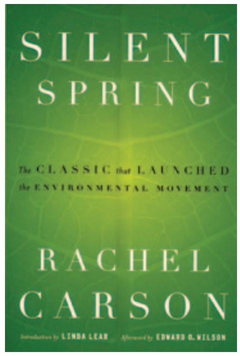
Galvanizing plant science in Europe will depend on an overhaul of the tangle of indefensible regulations themselves, not on the advent of new plant breeding technologies that may escape existing rules.



Rachel Carson's *Silent Spring* espouses the application of new biological technologies to address environmental and agricultural challenges facing humanity. SOURCE: Houghton Mifflin

> "Any society goes through social movements or fads, in which economically useless things become valued or useful things devalued temporarily. Nowadays, when almost all societies on Earth are connected to each other, we cannot imagine a fad's going so far that an important technology would actually be discarded. A society that temporarily turned against a powerful technology would continue to see it being used by neighboring societies and would have the opportunity to reacquire it by diffusion (or would be conquered by neighbors if it failed to do so)."
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> Jared Diamond, *Guns, Germs and Steel*[1]

An array of approaches is becoming available for manipulating the genetic content of plants and animals. Such approaches are gaining attention from regulators, particularly in Europe, where the question is whether new technologies should fall under the same restrictive regulatory framework as plants modified using the traditional transgenic approaches[2]. This is of central importance because restrictive European regulations have not only had pernicious effects on applied plant science throughout Europe, but have also been a factor in the closure of major R&D facilities of European agrochemical companies[3]. Even if legislative loopholes could be found that would allow biotech plant products produced by new technologies to move forward outside of existing regulations, we argue here that the Gordian knot binding European plant science through continuing policy failure and political timidity will remain uncut.

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Regulatory myopia

It is, in general, highly commendable (and all too rare) that regulators look ahead with the intent to ensure that their mechanisms for oversight and safety assessment/assurance are appropriate to anticipated developments. But much as armies are often judged for preparing to fight the last war rather than the one that looms, so, too, regulators must do more than look a year or three down the road to prepare for the future. One of the most important, and most often mishandled challenges facing regulators, is the need frequently to recalibrate the level of scrutiny they apply to a class of products so that it is defensible in the light of the actual hazard intrinsic to a product.

The reasons this challenge is often mishandled are legion: not only is it philosophically difficult to re-evaluate one's presuppositions, but vested interests and institutional imperatives create inertia and sometimes overt obstacles to change. But the world has seldom seen a greater discrepancy between the inherent hazard of a product and the level of regulatory burden imposed on it than exists today for crops improved through biotech. It is important, here, to be very clear: there is no basis in science for regulation specific to crops and foods improved through biotech or 'GMOs'[4–7].

Looking back

In 1953, James Watson and Francis Crick divined the structure of DNA, noting wryly near the end of their paper that "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material."[8] Over the subsequent several decades, an army of researchers discovered and illuminated the numerous mechanisms by which DNA is recombined in nature, and learned how to use those techniques in the laboratory. They figured out how to harness these natural processes to create old medicines in new ways and to impart new characteristics to plant varieties in a fraction of the time it previously took, using techniques discovered by evolution before the dawn of humanity. As a consequence, crops improved through biotech—we purposely avoid 'genetically modified (GM) crops' as a term as it does little more than reinforce ignorance of the fact that all crop improvement is mediated by genetic modification—have been grown by now on well over a billion hectares in more than 30 countries by nearly 17 million farmers, 15 million of whom are resource-poor smallholders in developing countries[9].

The economic and environmental impacts of biotech crops have been overwhelmingly positive. "In 2009, the direct global farm income benefit from biotech crops was $10.8 billion. This is equivalent to having added 5.8% to the value of global production of the four main crops of soybeans, maize, canola and cotton. Since 1996, farm incomes have increased by $64.7 billion…in 2009, 53.1% of the farm income benefits have been earned by developing country farmers…. Over the fourteen years, 1996 to 2009, the cumulative farm income gain derived by developing country farmers was also 49.2% ($31.85 billion). Since 1996, the use of pesticides on the biotech crop area was reduced by 393 million kg of active ingredient (8.7% reduction) and the environmental impact associated with herbicide and insecticide use on these crops, as measured by the EIQ (environmental impact quotient) indicator, has fallen by 17.1%"[10].

Looking forward

The increased production of food and feed derived from these crop varieties has comprised billions upon billions of meals eaten by humans and livestock around the world.

To our knowledge, every claim of a negative consequence to health or the environment from the use of these crops has failed to withstand scrutiny. Indeed, one of the signal benefits of the explosive uptake by farmers around the world, wherever they have been allowed access, is that they have brought life to the vision of the future first articulated by Rachel Carson[11] when she described the new paradigm she hoped for in the relationship between humans and our environment. In 1962, Carson wrote: "A truly extraordinary variety of alternatives to the chemical control of insects is available. Some are already in use and have achieved brilliant success. Others are in the stage of laboratory testing. Still others are little more than ideas in the minds of imaginative scientists, waiting for the opportunity to put them to the test. All have this in common: they are *biological* solutions, based on understanding of the living organisms they seek to control, and of the whole fabric of life to which these organisms belong. Specialists representing various areas of the vast field of biology are contributing—entomologists, pathologists, geneticists, physiologists, biochemists and ecologists—all pouring their knowledge and their creative inspirations into the formation of a new science of biotic controls"[11].

It is not sufficient, then, merely to catalog a handful of innovations in plant breeding technologies that could help magnify farmer's abilities to meet the exploding demands for food, feed and fiber that are foreseen over the next few decades. The size of the challenge means that impediments must not be tolerated, especially if we want to leave land for uses other than humans to live on or raise food—if we want to set land aside for biodiversity, for wilderness. It is imperative that the impediments now obstructing innovations in these critical areas be examined, and those that cannot be justified must be removed[12].

The fact is that the new breeding technologies will make their contributions to improving yield and sustainability primarily as they are integrated with technologies that were on the cutting edge not long ago, but are now quite conventional. These include recombinant DNA technology, as well as *Agrobacterium*- and particle bombardment-mediated transformation, all of which continue to be discriminated against by the European approach to regulation. By any honest reckoning, the level of scrutiny to which crops improved through biotech are subjected is completely unwarranted by the body of knowledge acquired over three decades of experience with such crops, including 15 years in commercial production. This is true around the world, but nowhere is the chasm between regulatory regime and the implications of facts and experience greater than in Europe. Although Europe is sufficiently wealthy to buy its food, the indirect effects of European regulations and attitudes have had a unconscionably inhibitory effect on the introduction of biotech crops in less developed countries in most need of them, particularly on the African continent[13].

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