nature biotechnology

Agnostic about agriculture

Averting a global food crisis will require the deconstruction of several hurdles to the deployment of new strategies in plant breeding.

Last October, just 12 years after the 6 billionth person was born, the United Nations declared that 7 billion people now inhabit the earth. Of these 7 billion, close to a billion are chronically undernourished and another billion are malnourished. The world's population will swell to 9 billion in the next 50 years, during which the human race will consume twice as much food as it has since the beginning of agriculture, 10,000 years ago. As the rate of population growth outstrips the rate of yield growth for crop staples, the world faces a food crisis that will require unprecedented intellectual, financial and material investment. It will also require the full deployment of every plant breeding technology currently available, including the generation of crops via transgenesis. But even more importantly, it will necessitate a reemphasis on innovation, greater diversification of the agrochemical and agbiotech industry, streamlining and harmonization of regulatory oversight, and an end to the political grandstanding that has characterized the agbiotech debate so far.

The world's burgeoning population is not the only threat to world food security. Changing lifestyles in developing countries, competition from subsidized biofuels, marginalization of land by soil erosion and salinity, deterioration of natural resources and dwindling of groundwater levels also contribute: not to mention climate change. Meeting these challenges will involve improving local access to resources and good farm practice; enhancing soil, water, nutrient and pest management; providing microcredits; and strengthening local markets, among other measures.

Crop improvement will also be key, necessitating the deployment of the best plant breeding technologies currently available. This issue of *Nature Biotechnology* brings together several articles highlighting how these novel technologies, such as zinc-finger endonuclease genome engineering, oligonucleotide-directed mutagenesis and RNA-dependent DNA methylation, might help in the future. None of those approaches provide a panacea for world food demand, but each may be part of the solution. And yet several factors currently stand in their way.

One obstacle is the level of investment in agriculture R&D. In 2012, the research budgets of the US Department of Agriculture and European Commission under the Common Agricultural Policy are only $2.3 billion and €4.5 billion, respectively… chicken feed compared with the US National Institutes of Health budget of $31.2 billion. Private R&D funding levels are also less than ideal. A December report from the USDA's Economic Research Service (ERS) highlights consolidation in the agrochemical market, which has not only reduced the number of companies in the sector and expanded their individual size but also slowed increases in R&D investment. In 2008, only 30 agbiotech startups were active, with less than one per year founded between 2004 and 2009. None was started in 2008 or 2009. Multinational agrochemical companies account for 70% of total R&D spend in seed biotech, other (non-multinational) seed companies 26%, and agbiotech startups only 4%.

With so little competition in research, it is unsurprising that the output of new traits from the agricultural sector is underwhelming. Of 160 million hectares of transgenic crops planted by 16.7 million farmers in 29 countries last year, most were based on decades-old technology: *Bacillus thuringiensis* (*Bt*)-toxin maize, soybean and cotton, glyphosate-resistant cereals and/or stacked varieties. And although there are new varieties with improved tolerance to biotic or abiotic stresses—a drought-resistant maize strain was just approved in December—these are coming to market at a glacial pace.

Which raises the key problem: regulation. In Europe, since the mid-1980s, regulators have shifted from evidence-based risk assessments to implementation of rules that specifically discriminate against transgenic products and emphasize the precautionary approach. Those rules kick in when a transgene is involved anywhere in crop development, even if the final product doesn't contain foreign DNA. This is all the more disturbing given that regulators are currently trying to assess which additional new plant breeding techniques are captured within this framework (see p. 231). Stateside, the Environmental Protection Agency is proposing expanded rules to codify data requirements for plant incorporated protectants, suggesting that it, too, is moving toward the precautionary principle.

This continued regulatory expansion is perturbing, especially given that current rules were initially instigated only because data on the risks of genetic modification were deemed insufficient. The fact that we now know better seems not to count for anything. There is no scientific uncertainty about whether crops generated via transgenesis are riskier than conventionally produced varieties. They simply are not! And thus regulatory oversight should be reined in, not ramped up.

Overburdensome regulation adds to the time and cost of new crop development—on average, 4 years and €6.8 million per variety in Europe. Paradoxically, it also reinforces the corporate monopolies that many transgenic technology opponents rail against—only multinationals have pockets deep enough to navigate the regulatory system. It also sets a poor example to governments in developing countries that look to the West for guidance on how to implement their own regulatory frameworks. In turn, a lack of clear regulation in developing countries stymies local efforts to bring crops with novel traits to market and spreads uncertainty as to whether products will be excluded from the European market.

Policymakers need to wake up and recognize that the lack of incentives for innovation in both the private and public sectors is compromising the world's ability to combat hunger. As product development can take decades in agriculture, action needs to be taken now to deregulate proven technologies and shift regulation to assessment of the crop traits themselves. Stopgap, Band-Aid solutions will not be enough. When food shortages come—and they will, even to regions where food availability is currently high—coming generations will ask why more was not done to deploy the full range of plant breeding technologies available.