

Whither agbiotechnology?

L Val Giddings

What will the agbiotech landscape look like in 2016? And what form will the 'doubly green' revolution take?

"Any society goes through social movements or fads, in which economically useless things become valued or useful things devalued temporarily." Jared Diamond, *Guns, Germs and Steel*, W.W. Norton, 1998, p. 257

Biotech became a feature of commodity production agriculture ten years ago, with the introduction of insect pest-protected corn varieties. Though readers of this journal should not have been surprised, most probably did not anticipate that in the following decade, more than a billion cumulative acres would be grown in 21 countries by over 8 million farmers, 90% of them poor and in developing countries¹. This marks the most rapid introduction of a new technology in the history of agriculture. Like most transformations, this one has been attended by controversy and opposition. How will the trends and factors now in play transform the landscape over the next decade?

I think all but a few science fiction writers have underestimated the transformation that has begun. Biotech has been called a Promethean science² and it is in the process of transforming the relationship between humans and the planet. Ironically, most of the goals for agricultural transformation sought by environmentalists (e.g., improved sustainability and reduced environmental footprint) are most likely to be rendered through what many perceive as their nemesis: applications of agricultural biotech. What products will dominate in 2016? And what challenges must be overcome for this doubly green³ revolution to come to pass?

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Look closer—you are about to witness the transformation of agriculture across the globe

The best is yet to come

There is no doubt in my mind that in ten years, biotech will be the dominant global paradigm in commodity agriculture. It is then, however, that things will begin to get really interesting. For the next major growth sector, the smart money is on products with value added for the end-consumer. Biotech will help enable food processors to reduce the *trans*-fat content of foods and the related concerns that worry them. Functional foods with a variety of nutritional and health-related improvements will complement and expand these changes. Though several major food corporations presently position themselves as GM-free, the food industry is poised to become the best friend of biotech companies and consumers simultaneously. Value-added animal feeds will also be huge (remember, the majority of grain grown in temperate latitudes today feeds livestock, not humans),

enhanced in a variety of ways that improve production efficiency and reduce environmental impacts. But we will continue to see significant additional growth of plant traits benefiting producers. The complex genetic control of water metabolism is now becoming commercially tractable, presaging the introduction of drought- and saline-tolerant crops. Maturation and ripening are also becoming more easily manipulated in ways that will have significant implications for nutrition, health, production and processing economics, and more.

All these opportunities for plant modification stand to be transformed by next-generation technologies, like mini-chromosomes, that will enable the choreographed introduction of multiple genes into plants. Products based on manipulated gene expression patterns will also become much more common, particularly through genetic use restriction technologies, which will be used to switch traits on and off *ad libitum* (with flexible royalty schedules, no doubt), and also for intellectual property management and safety assurance. And although manipulation of biosynthetic pathways through gene expression will play a larger role, this will supplement, not displace transformation with exogenous DNA.

But to keep a narrow focus on improved plants would be to overlook a huge sector of the landscape: animals. We can expect that production of livestock, especially cattle, swine, poultry and aquatic species (tilapia, carp, salmonids, shrimp and shellfish) for human consumption will be transformed in a host of ways. Reproductive techniques, such as marker assisted selection and cloning, will transform breeding and make elite stock even more the norm and standard than they have already become. Improvements in husbandry on many fronts will enhance production efficiency and safety. A variety of methods to

reduce the environmental burden of livestock production will have significant impacts, and may help complete the accelerating erosion of European resistance rooted in politics and short-term economics. Indeed, the revolution about to be visited on animal agriculture may make the pace of change in plant agriculture seem sedentary.

As impressive as the changes will be in these more traditional agricultural orbits, transformations looms in other sectors. Industrial fine chemical production, biomass energy, forestry, biodiversity protection and management, and direct production of vaccines and therapeutic medical compounds in plants and particularly in large animals are all poised for significant and rapid evolution and growth.

Roadblocks

All in all, then, a bright future full of potential. But what are the obstacles that must be overcome?

Investment patterns. It has never been easy to turn a grubstake into a gold mine, but the field of opportunities that can now be glimpsed for agbiotech presents an embarrassment of riches. But little of this envisioned future will come to pass if it is not fueled by investment. And as important as government policies and R&D support are, unless we see a reversal of the steady decline over recent decades of state support for basic agricultural research, the dynamic driver will continue to be private sector investment. A side note here is that activists objecting to the large role played by the private sector could do something constructive about this by making common cause with industry in lobbying for greater government support for basic research. The disincentives to private sector investment are well known, and at the top of the list is uncertainty. The most important sources are regulatory unreason and public resistance. If government blocks your product's access to the market, doom is swift. If the customer won't buy it once it hits the market, doom is also certain. What can we expect on these fronts?

Regulatory unreason. The principal locus of global regulatory unreason is not Brussels, but a non-European could be forgiven for thinking so. In fact, the unreason that blooms in Brussels is rooted in national capitals where it is an artifact of many forces. None is more important than the peculiarities of parliamentary democracy, which in this case magnify the consequences of short-term financial self-interest and cynical power

politics masquerading as concern for the environment. But the positive environmental impacts of no-till agriculture and the frequent superiority to all alternatives of biology-based solutions to agricultural problems are increasingly difficult to deny. Few outside Europe are diverted by the weak arguments of the opponents, and strong signals suggest the resistance in Europe is crumbling—which is to say, naked self-interest is in the ascendant. And the rest of the world is well on the way to full-scale embrace of biotech in agriculture¹. But vision-impaired governments still can have a negative impact on the rate and scope of progress.

Europe has no monopoly on unreason. There has been a surprising dearth of government leadership in the United States over the past several years, and long-awaited adaptations of the existing, robust regulatory regime to emerging challenges in both the plant and animal worlds are eagerly awaited. Administration guidance on animal cloning is long overdue, and its release will have

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a galvanic effect. All reasonable questions and more seem to have been answered about transgenic salmon, and a decision on this product should reach the end of its *decade* of FDA scrutiny soon. The fact that these decisions are so many years behind schedule is a surprise, and a major misstep one would not have expected from those now in power. The present US Administration does not seem to recognize the need to adapt regulations to lessons learned from experience at a rate consistent with the rapid pace of technological advance. Instead of reducing current burdens on the majority of applications shown to be straightforward and at least as safe as expected, and refocusing scrutiny on remaining areas of uncertainty, the trend seems to be towards more generally strict application of regulations that are being rapidly outmoded by technological developments. There is a better way. Let us hope those in government corridors discover it soon.

There are reasons for good cheer on the international front, however, as four new countries joined the ranks of last years' 17

in growing crops improved through biotech¹. To the dismay of Luddites, three of these are in Europe (Portugal, France and the Czech Republic). Canada is holding steady, Latin America is moving forward, most notably in Brazil, and regulators at the federal level in Australia continue to make reasoned decisions based on the facts, despite political foolishness at the state level (several GM bans at the US state level suggest that local Australian officials have no monopoly on fecklessness). But the overall global trends are favorable. In another decade the number of countries growing biotech crops could easily break 60.

Public acceptance. Here we enter the realm of smoke and mirrors, or, in Benjamin Disraeli's phrase, "Lies, damn lies, and statistics."

Statistical tools are insufficiently robust when data are derived from self-assessment by inconstant humans. A well-constructed public opinion poll can produce solid data that allow sound conclusions, but folks who actually want good data and can pay for it are outnumbered by those with an axe to grind and a pecuniary interest. So the field is awash with unreliable push-polls serving various ulterior motives. Thankfully, there is a sword for this Gordian knot. Looking past what people say they think in response to cleverly worded questions, and measuring what they actually do, we see consistent patterns emerge. There are exceptions to the rule, but around the world, food consumers faced with choices more often than not cast their economic ballots for lower prices and better flavor, in that order. Those concerned about safety do not rank biotech as a production method about which they are most concerned. This is why the activists opposed to biotech fight so hard to demonize it with misleading campaigns to stoke fear, to stigmatize biotech with misleading labels and in fact to deny consumers the choice they claim to favor. But despite sporadic activist successes on rare favorable turf, the facts will out, and consumers around the world are accepting foods derived from crops improved through biotech. This will accelerate as qualities of direct interest to consumers proliferate, and the activists will have to move to new fund-raising gimmicks as increased sunlight reduces the bogey-man value of biotech.

Changes in the wind

Assuming that regulation presents no fatal obstacles and public acceptance continues to increase, what changes can we expect in the business landscape?

Consolidation will no doubt continue, driven by one of the strongest forces in the

history of humanity: the desire for cheaper food. Agriculture will continue change along multiple axes: some driven by technological advance, some by consumer pull and some by changing government policies as the consequences of the World Trade Organization's (Geneva, Switzerland) Uruguay Round and 2001 Doha Agenda—perhaps the most major reform of global trade in recent history—continue to unfold.

Big companies will continue to adapt their business plans at varying rates, and their financial success will vary accordingly. The dominant big six of today will certainly be reduced to five, if not four, over the next decade. On the other hand, I believe small companies will continue to proliferate because the new opportunities are even more numerous than the substantial challenges. These enterprises will either be snapped up by bigger fish or, rarely, manage their own metamorphoses into established mature and sustainable businesses themselves.

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Indeed, though commercial success by today's major corporate players will certainly be much larger a decade on, the outlook will be dramatically different. A subset of today's small and medium enterprises will have achieved major commercial success, and more academics will find, as shown by the transgenic papaya example, that they have overestimated the regulatory obstacles. The constellation of global players will be radi-

cally different as the technology diffuses overseas. The success of biotech rice in Iran, and its imminent success in China, signal a looming transformation in the global landscape.

Governments rarely move with alacrity, so even if the downward trends of public sector support for agriculture research are reversed, it is most likely that private money will continue to impel the most rapid innovations and change. No doubt, there will be surprises, pitfalls, missteps and foolish choices. But in ten years time, we will likely look back and wonder how we ever could have doubted.

1. James, C. *Global Status of Commercialized Biotech/GM Crops: 2005*. ISAAA Briefs No. 34. (International Service for the Acquisition of Agri-biotech Applications, Ithaca, New York 2005).
2. Serageldin, I. & Persley, G.J. *Promethean Science: Agricultural Biotechnology, the Environment, and the Poor* (Consultative Group on International Agricultural Research, Washington, DC, 2000).
3. Conway, G. *The Doubly Green Revolution: Food for All in the 21st Century* (Comstock Publishing Associates, Ithaca, NY 1997).