
# Who Owns Nature?

## Corporate Power and the Final Frontier in the Commodification of Life

etc group

November 2008

etc group
action group on erosion, technology and concentration

Communiqué

November 2008 Issue #100

# Who Owns Nature?
## Corporate Power and the Final Frontier in the Commodification of Life

**ETC Group**
**www.etcgroup.org**

November 2008

Publication Design by Wordsmith Services and yellowDog : creative

Original Artwork by Stig

# Table of Contents

# Problems, Fascinations and Opportunities: A Preface

Three decades ago, humanity had a problem; science had a fascination; and industry had an opportunity. Our problem was injustice. The ranks of the hungry were expanding while the ranks of farmers were thinning. Meanwhile, science was fascinated by biotechnology – the idea that we could genetically engineer crops and livestock (and people) with traits that could overcome all our problems. Agribusiness saw an opportunity to extract the enormous surplus value that was laced throughout the food chain. The hugely-decentralized food system held pockets of profit just crying out to be centralized. All industry had to do was convince governments that biotech's gene revolution could end hunger without harming the environment. Biotechnology was presented as too risky for small companies and too expensive for public researchers. In order to bring this technology to the world, public breeders would have to stop competing with private breeders, regulators would have to look the other way when pesticide companies bought seed companies which, in turn, bought other seed companies. Governments would have to protect industry's investments by offering patents first on plants and then on genes. Consumer safety regulations, hard-won over the course of a century, would have to yield to genetically modified foods and drugs.

Industry got what it wanted. From thousands of seed companies and public breeding institutions three decades ago, ten companies now control more than two-thirds of global proprietary seed sales. From dozens of pesticide companies three decades ago, ten now control almost 90% of agrochemical sales worldwide. From almost a thousand biotech startups 15 years ago, ten companies now have three-quarters of industry revenue. And, six of the leaders in seeds are also six of the leaders in pesticides and biotech. Over the past three decades, a handful of companies has gained control of that one-quarter of the world's annual biomass (crops, livestock, fisheries, etc.) that has been integrated into the world market economy.

Today, humanity has a problem; science has a fascination; and industry has an opportunity. Our problem is hunger and injustice in a world of climate chaos. Science's fascination is with convergence at the nano-scale – including the potential to design new life forms from the bottom-up. Industry's opportunity lies in the three-quarters of the world's biomass that (although used and useful) remains outside the global market economy. With the aid of new technologies, industry believes that any chemical made from the carbon in fossil fuels can be made from the carbon found in plants. The oceans' algae, the Amazon's trees and savanna grasses can provide the (purportedly) renewable raw materials to feed people, fuel cars, manufacture widgets, and cure diseases while fending off global warming. In order for industry to realize this vision, governments must accept that this technology is too expensive. Competitors must be convinced it is too risky. Regulations need to be dismantled and monopoly patents need to be approved.

*New technologies don't have to be socially useful or technically superior in order to be profitable.*

And, as it was with biotechnology, the new technologies don't need to be socially useful or technically superior (i.e., they don't have to work) in order to be profitable. All they have to do is chase away the competition and coerce governments into surrendering control. Once the market is monopolized, how the technology performs is irrelevant.

**Large Numbers: How Many Zeros?**

In this report, ETC Group uses the following number-naming system:

One million = 1,000,000 = 1 million

One billion = 1,000,000,000 = 1,000 million

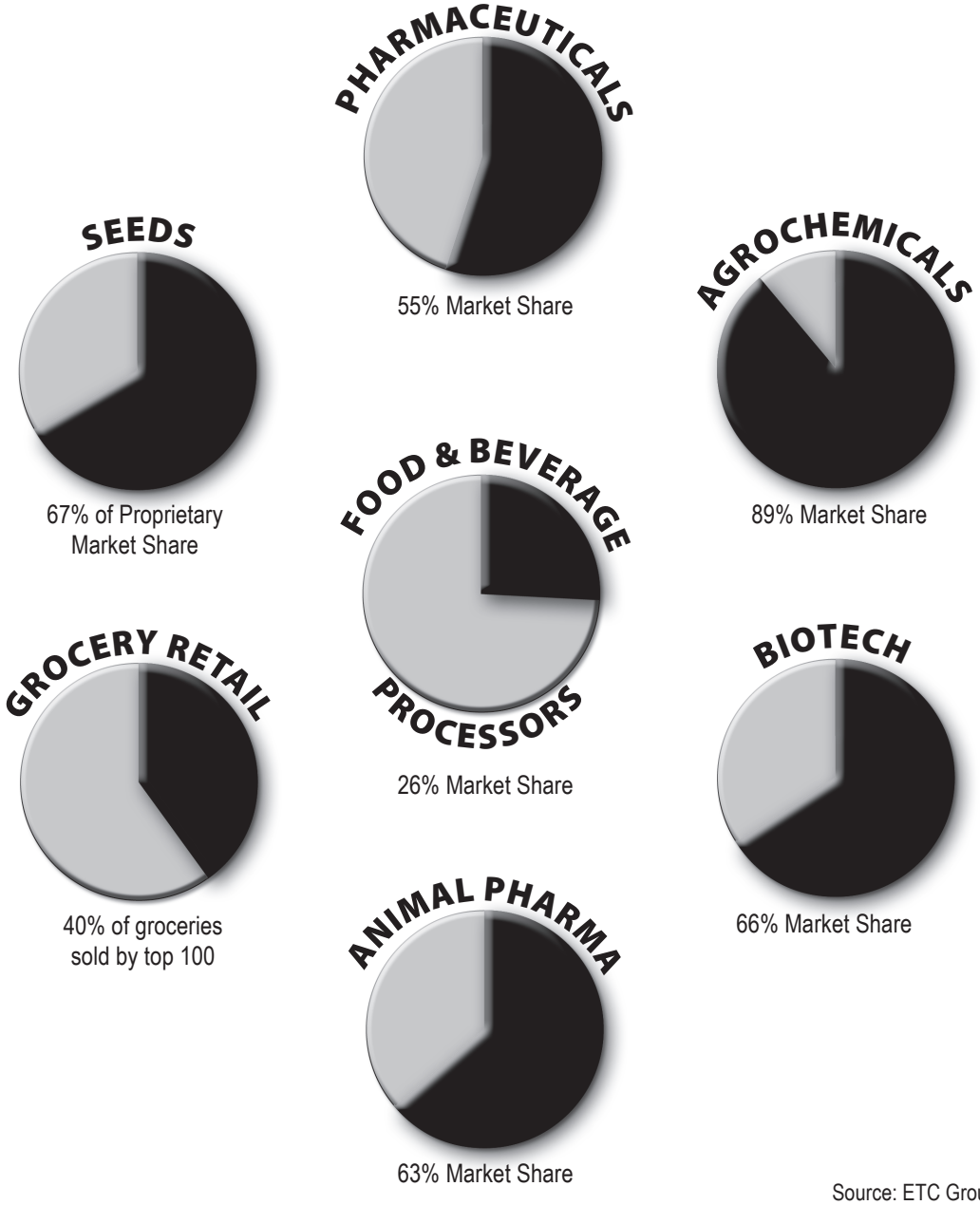
One trillion = 1,000,000,000,000 = 1,000,000 million

$20 trillion is the same as $20,000 billion, which is the same as $20,000,000 million, or $20,000,000,000,000

## Who Owns Nature?

In this 100th issue of the ETC *Communiqué* we update *Oligopoly, Inc.* – our ongoing series tracking corporate concentration in the life industry. We also analyze the past three decades of agribusiness efforts to monopolize the 24% of living nature that has been commodified, and expose a new strategy to capture the remaining three-quarters that has, until now, remained beyond the market economy.

## Top 10 Corporations Global Market Share by Sector




Source: ETC Group

## The Context

The 100th issue of ETC Group's *Communiqué* provides an update on corporate concentration in the life sciences industry. We have been monitoring corporate power in commercial food, farming, and health for three decades. Ten years ago, ETC Group monitored control and ownership of biotech. Today, biotech is becoming "extreme genetic engineering." Technology convergence is re-defining life sciences. We've reached the point where it's difficult to talk about biotechnology without talking about *nanotechnology* and *synthetic biology*. All of the biosciences are fueled by *information technology* or *bioinformatics* – the computer-based analysis of biological materials. As a result, we

*…We can't understand corporate power if we don't understand the concept of convergence – converging technologies and converging capital.*

can't understand corporate power if we don't understand the concept of *convergence* – converging technologies and converging capital. Convergence is driving new and unprecedented corporate alliances across all industry sectors and setting the stage for a dramatic transformation of the global economy into what some call the "sugar economy" or "carbohydrate economy." Biological manufacturing platforms fueled by plant-derived sugars will provide the incentive for industry to capture and commodify the earth's remaining plant biomass on a colossal scale.

Amidst a world food crisis, collapsing ecosystems and climate chaos, new technologies are once again being promoted by international institutions, governments and Big Business as the magic bullet for boosting food production and saving the planet. The idea of a technological fix for agricultural development is nothing new, but governments are stepping aside and inviting corporations to cast themselves as the key players in the fight against hunger and poverty. Instead of challenging or changing structures that generate poverty and exacerbate inequality, governments are working hand-in-hand with corporations to reinforce the very institutions and policies that are the root causes of today's agro-industrial food crisis.

Concentration in the life industry has allowed a handful of powerful corporations to seize the research agenda, dictate national and international trade agreements and agricultural policies, and engineer the acceptance of new technologies as the "science-based" solution to increase crop yields, feed the hungry and save the planet. The Gene Giants tell us that if agriculture is threatened by climate extremes, we need "climate-ready" genes (patented ones) to engineer crops to withstand drought, heat and saline soils. When hunger is viewed through the narrow lens of science and technology, genetically engineered foods are the corporate quick-fix. When Peak Oil is approached as a technical challenge, industrial agrofuels are the obvious answer. When technology is promoted as a painless solution to tackle global warming, radical geo-engineering schemes become a rational idea (e.g., let's brew vast phytoplankton farms on the ocean's surface to [supposedly] sequester carbon, or blast sulfate particles into the stratosphere to screen out sunlight and lower temperatures, etc.).

Promoted in the name of fighting hunger, increasing production and arresting climate change, technologies that reinforce corporate power are deepening existing inequalities, accelerating environmental degradation and introducing new societal risks.

**Things Fall Apart:** For the millions of people who spend 60-80 percent of their income on food, the impacts of spiralling food and fuel prices in 2006-2008 are "unprecedented in scale and brutality."[1] In 2006-2007, the number of food-insecure people rose from 849 million to 982 million. The U.S. Department of Agriculture's July 2008 assessment predicts that the number of hungry people in 70 South countries will increase to 1.2 billion by 2017.[2] In other words, rather than halving the number of hungry people by 2015 (the goal that governments have repeatedly pledged to meet) their ranks are projected to increase by 50%. The food import bill of 82 poor countries (designated Low-Income Food-Deficit Countries) is expected to reach US$169 billion in 2008, 40 per cent more than in 2007.[3] (To put that in perspective, governments meeting at the FAO Food Summit in June 2008 pledged just $12.3 billion to help countries in the South – and most of that has vaporized with the colossal corporate bailouts.)

According to Planet Retail, global food spending reached $7.0 trillion in 2007 and shot up 14% to $8.0 trillion in 2008. Global expenditures of food are expected to reach $8.5 trillion in 2009 – a projected increase of 21% between 2007-2009.[4]

The food emergency didn't emerge overnight, and it didn't begin with record-high prices. For decades, U.S. and European policies have favoured corporate agribusiness by keeping commodity prices low, dismantling trade barriers and marginalizing millions of small-scale farmers who couldn't compete with a deluge of subsidized food imports. Trends in world food trade shifted radically over the past 40 years. According to FAO's 2004 report on commodity markets, in the early 1960s developing countries had an overall agricultural trade *surplus* approaching US $7 billion per year.[5] By the end of the 1980s, the surplus had disappeared. Countries in the South reversed course in the almost two decades since then to become net importers of food. In countries categorized as "least developed," imports of agricultural commodities grew to more than twice the level of exports. The current tragedy stems from decades of depressed commodity prices, trade liberalization, withering investments in national agricultural programs, and the ever-increasing domination of the corporate agro-industrial food system.

In the second half of 2008, global financial markets are imploding and headline news is shifting from food crisis to financial crisis. There are striking similarities between the market meltdown and the food crisis:

► Both the financial system and the food system have suffered from decades of deregulation. The difference is that bankrupt banks are getting plenty of attention from politicians; lengthening lineups at food banks are not.

► The very institutions and policies responsible for creating the disaster are first in line to benefit from the crisis.

► Governments are working hand-in-hand with industry to ignore the root causes of the disaster and sidestep structural reforms.

Yet, the political reaction to the financial crisis is to call for a return to regulation, while the political response to the food crisis is to press for further deregulation. When the food crisis is defined as food scarcity and hungry people, the market-based prescription is to further liberalize markets and boost agricultural production with heavy doses of new technology. The real disaster is the corporate controlled agro-industrial food system. This system has entrenched corporate power while undermining the ability of small-scale producers to produce food for their own communities. No matter how much new technology is employed in the name of boosting food production, the agro-industrial food system is incapable of feeding hungry people. And that's because hunger and poverty are the consequences of inequitable systems – not food scarcity or inadequate technologies.

*The real disaster is the corporate-controlled agro-industrial food system.*

**Broken to Bits:** Deregulation of the corporate-controlled food system has resulted in a cornucopia of calamities: It is making us sicker, fatter and more vulnerable. Unhealthy and hazardous food products and related environmental disasters are constant reminders of a corporate food chain broken to bits. Recent examples include:

*Unhealthy and hazardous food products and related environmental disasters are constant reminders of a corporate food chain broken to bits.*

► **Food (un)safety scandals:** In September/October 2008 infant milk powder laced with an industrial chemical, melamine, sickened 53,000 Chinese infants and killed four. The scandal involved every major Chinese dairy company and spread to global brands of food products (chocolates, cheese, biscuits, etc.) around the world – resulting in massive recalls involving billions of dollars. After being discovered in animal feed, the scandal has grown to include unknown quantities of melamine-tainted eggs and meat products.

By October 2008 contaminated cold cuts in Canada had killed 20 and sickened hundreds more, exposing the fact that virtually all of Canada's cold cuts come from a single processing plant owned by a single company, regardless of brand name or destination.

In February 2008 a record 143 million pounds of hazardous hamburger were recalled in the U.S. According to the U.S. Centers for Disease Control, every year in the U.S. 76 million people get sick, 325,000 are hospitalized and 5,000 die from foodborne hazards. The economic costs of serious illness and

death from the five most common food-borne pathogens reached almost $7 billion in 2000.[7]

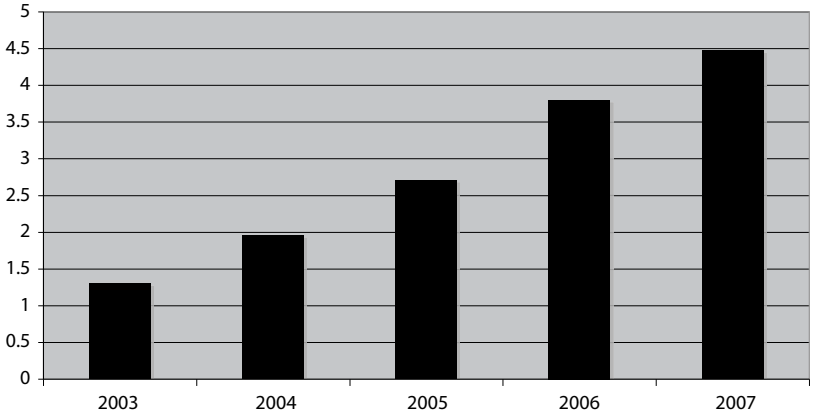
► **Plastic Peril:** In October 2008 Canada confirmed that bisphenol A (BPA) – a chemical used to make plastic baby bottles and water bottles (and found in the lining of nearly every soft drink can and canned food product) – is a toxic substance, particularly dangerous for infants. In the U.S. alone, more than 6 million pounds of products containing BPA are produced per annum.

► **Obesity Burden:** The global obesity epidemic is one of the world's greatest public health challenges. A new study reveals that almost one-third of the world's adult population is overweight or obese.[8] In 2005, an estimated 23% of the world's adult population was overweight (937 million), and nearly 10% were obese (396 million).[9] Of the 396 million obese people, 53% lived in developing countries. If trends continue, there will be 1.2 billion obese people by 2030 and 62-68% of them will live in the global South.[10] In the U.S. alone, the economic cost of obesity was about $117 billion per annum in 2000.[11]

► **Dead Zones:** Chemical fertilizer pollution is the primary cause of 400 coastal "dead zones" that now cover an area of 245,000 km$^2$ (the size of the U.K. or Ghana). Oxygen-depleted marine waters have increased by one-third since 1995.

► **Engineering Taste:** The corporate food system has redefined the notion of fresh food by overcoming barriers that were once imposed by nature (or by regulators). Dutch author Jan Douwe van der Ploeg describes how the tenderness and taste of industrial chicken, for example, is not necessarily related

**Value of Global Mergers & Acquisitions (US$ trillions)**




### Corporate Excess, Disparity and Inequality

According to labor economist Tom Pizzigati, the combined net worth of today's 1,125 billionaires ($4.4 trillion) is likely to exceed the combined wealth of half of the world's adult population.[16] Put in another way, the combined worth of the world's wealthiest 1,125 individuals exceeds Germany's 2007 gross national income.

According to the Institute for Policy Studies, CEOs of the top 500 U.S.-based corporations averaged $10.5 million in pay in 2007, 344 times the pay of typical American workers. The top 50 hedge and private equity fund managers averaged $588 million each in 2007, more than 19,000 times the amount earned by the typical U.S. worker.[17] Even as government coffers are bailing out investment banks, corporate CEOs continue to cash prodigious paychecks. The CEO of now-bankrupt Lehman Brothers, took home $17,000 per hour in 2007 – about $45 million – for driving his company into the ground.[18]

In August 2008 ExxonMobil, the world's second largest corporation, was gushing record-breaking profits at the rate of $90,000 *per minute*.[19] Referring to the CEO of Exxon and other oil industry giants, NASA climatologist Dr. James Hansen told a U.S. Congressional committee that these executives "should be tried for high crimes against humanity and nature" for engineering doubt about global warming and obstructing corrective measures.[20]

In 2007, Wal-Mart's revenues were higher than gross national income in Greece or Denmark. BP's 2007 revenues exceeded South Africa's gross national income; Toyota's 2007 earnings topped Venezuela's.

In 2004, America's wealthiest 1% of the population held 35% of the nation's total wealth – over $2.5 trillion *more* in net worth than the entire bottom 90%.[21]

A 2008 OECD report reveals that the U.S. has the highest inequality and poverty rates in 20 OECD countries after Mexico, Turkey and Portugal.[22]

to breed, feed or treatment, but may be the result of "the injection of water, additional proteins, softeners and flavours into any breed of chicken."[12] Dark chicken meat, adds van der Ploeg, "is milled, mixed with water into a meat ooze, centrifuged and cooked, after which a whitish chicken filet…is obtained."[13] He estimates that 80 percent of food industry R&D is oriented towards the manufacturing of these kinds of "boundary shifts."

### Consolidation Trends:

According to industry analysts, in 2007 the aggregate value of global food industry mergers and acquisitions (including food processors, distributors and retailers) was roughly $200 billion, compared to half that amount in 2005.[14] The mergers in this sector mirror the global trend in mergers and acquisitions.

In 2003, the worldwide value of mergers and acquisitions totaled a record-breaking $1.38 trillion. By 2005 it ballooned to $2.7 trillion – and then spiked 27% to reach $4.48 trillion in 2007.

*"Our world is not for sale."* [23]

### The Global Food Fight

The statistics and analysis in this report provide a snapshot of technology convergence and corporate concentration in the industrial life sciences. It is difficult to exaggerate the power and reach of corporate actors in the global food and health arena. At the same time, there is vast and growing resistance to the dislocation and devastation caused by the agro-industrial food system. Millions of people are struggling for locally controlled and socially just food systems ("Food Sovereignty," as defined by Via Campesina, what others have called a global repeasantization movement).[24] Peasant farmers, civil society and social movements are actively creating alternative food and health systems built on resilience, sustainability and sovereignty.

In the global struggle for Food Sovereignty, the playing field isn't level, but the scope and scale of resistance is massive, extending from the local to the international level. For all their power and might, corporations do not have a monopoly on innovation and knowledge. Even after decades of marginalization by corporate food systems, the vast majority of the world's food is produced in local food economies by peasant farmers, fisherfolk, pastoralists and indigenous peoples. They are the backbone of the world's food system. Peasant farmers conduct more scientific research and breed far more plant varieties than corporations. Collectively, they constitute a repository of knowledge and innovation that rivals all the patent offices in the world. While the global struggle for land, food and justice is playing out on a lopsided playing field, it's also true that our view of corporate power is often a distorted one. A lot depends on perspective:

Although Wal-Mart is the largest buyer and seller of food on the planet, it accounts for only 3.5% of the $5.1 trillion dollars spent on retail food worldwide in 2007. An estimated 85% of the world's food is still produced relatively close to where it is consumed[25] – much of it outside the formal market system. Of the world's 450 million farms, 85% are smallholder farms of less than 2 hectares.[26]

While the proprietary seed market accounts for over 80% of the commercial seed supply, approximately three-quarters of the world's farmers routinely save seeds from their harvest and grow locally-bred varieties. At least 1.4 billion people depend upon farmer-saved seed. In 2007, institutional breeders

#### Power to the people… or, power to the bottom?

In the globalized marketplace, to be on top, you need to control the bottom. The greatest power resides at the most fundamental level. From the perspective of agribusiness over the past three decades, power has moved from the seed to the gene to the atom. Tomorrow, power may flow to those who control genomic databases. We used to say that if you controlled the seed, you controlled the first link in the food chain. Then, gene patents in the 1990s undermined the plant variety patents of the 1970s. Now, nanobiotechnology patents threaten to usurp control to the atomic level. Power follows gravity, it seems.

But, not really. Sow a bag of atoms and the chances of a bumper crop are dismal. Throw a mess of genes into a pot and dinner will be delayed. Plant seed and feed the family. Over the last three decades we have learned that genes play only a bit part in creation and atoms are a long way from the bottom of the physical universe. But, seeds (mixed in soil, water and sunlight) are, in truth, the first link in the food chain. Seed is the fundamental source of political power that governments must not forget and farmers need to protect.

held monopoly claims (plant variety protection) on over 72,000 plant varieties worldwide (many of them flowers and ornamentals). But small farmers have created and are using millions of farmer-bred varieties, mostly food crops.[27]

Half of the world's population now lives in cities, and problems associated with urban poverty are profound. However, it is conservatively estimated that 15-20% of the world's food is produced in urban areas, and 800 million urban residents are involved in some form of agriculture.[28] Sixty-four per cent of the residents of Nairobi grow at least some of their own food.[29] In Kathmandu 37% of food producers grow all the vegetables consumed in their households, and 11% of animal products.[30] In Hanoi, 80% of fresh vegetables, 50% of pork, poultry and fresh water fish, as well as 40% of eggs, originate from urban areas.[31] In Accra, 90% of the city's fresh vegetables are produced within the city. [32]

The top 10 drug companies account for 55% of global pharmaceutical sales, but approximately 70% of the world's population depends on traditional, herbal-based medicines for the majority of its health care.

For most of the world's population, farmer-bred crops and traditional medicines are vastly more accessible and affordable. They are diverse, patent-free, decentralized, and adapted to thousands of cultural, environmental, climate and geographical conditions. Peasant farming communities are those that have the labor, resources, knowledge and resilience to sustain agro-ecological farming practices – and these are the people who will be responsible for adapting agriculture to extreme climate conditions. They are the true experts in "life sciences," and it's their science and technologies that deserve support and recognition. Readers of *Who Owns Nature?* should keep in mind that the global food fight isn't over.

*"The largest corporation is not Wal-Mart or General Motors; the largest corporation is nature."*

*- Ahmed Djoghlaf, Executive Secretary of the U.N. Convention on Biological Diversity, 18 May 2008*

## Notes

1 Olivier De Schutter, "Building resilience: a human rights framework for world food and nutrition security," Report of the Special Rapporteur on the right to food, United Nations General Assembly, 8 September 2008.

2 Stacey Rosen, et al., "Food Security Assessment 2007," USDA, Economic Research Service, July 2008.

3 FAO, "Food Outlook: Global Market Analysis," June 2008. http://www.fao.org/docrep/010/ai466e/ai466e00.htm

4 Personal communication with Boris Planer and Sarah Herriein, Planet Retail, May 2008.

5 FAO, The State of Agricultural Commodity Markets 2004, p. 14. This statistic is not adjusted for inflation. On the Internet: http://www.fao.org/docrep/007/y5419e/y5419e03.htm

6 Caroline S. DeWaal, and David W. Plunkett, "Building a Modern Food Safety System: For FDA Regulated Foods," Center for Science in the Public Interest White Paper, October 2007. On the Internet: http://www.cspinet.org/new/pdf/fswhitepaper.pdf

7 *Ibid.*

8 T. Kelly, et al., "Global burden of obesity in 2005 and projections to 2030," *International Journal of Obesity* (2008) 32, 1431–1437; published online 8 July 2008.

9 *Ibid.*

10 Personal communication with Tanika Kelly, Tulane University. October 29, 2008.

11 U.S. Department of Health and Human Services, Office of the Surgeon General. "Overweight & Obesity: At a Glance." On the Internet: http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_glance.htm

12 Jan Douwe van der Ploeg, *The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization*, Earthscan: London, 2008.

13 *Ibid.*

14 Grant Thornton Corporate Finance. Personal communication with Brian Basil, October 24, 2008. For more information, see Grant Thornton's "Food Industry Snapshot," Summer, 2008.

15 Statistics on worldwide value of mergers and acquisitions are from Thomson Financial Securities.

16 See "Too Much" – a website that explores excess and inequality in the U.S. and the world, edited by Tom Pizzigati. http://www.toomuchonline.org/inequality.html

17 Institute for Policy Studies, "Corporate Excess 2008," http://www.ips-dc.org/reports/#623

18 Nicholas Kristof, "Need a Job? $17,000 an Hour. No Success Required," *New York Times*, September 17, 2008.

19 Clifford Kraus, "Exxon's Second-Quarter Earnings Set a Record," *New York Times*, August 1, 2008.

20 Robert Weissman, editor of *Multinational Monitor*, "Crime, Punishment and ExxonMobil. On the Internet: http://multinationalmonitor.org/editors-blog/index.php?/archives/90-Crime,-Punishment-and-ExxonMobil.html

21 See "Too Much" – a website that explores excess and inequality in the U.S. and the world, edited by Tom Pizzigati. http://www.toomuchonline.org/inequality.html

22 Andrew Taylor and Chris Giles, "Rich-poor divide widens, says OECD," *Financial Times*, October 21, 2008.

23 "Our World Is Not for Sale" is a worldwide network of organizations (including ETC Group), activists and social movements committed to challenging trade and investment agreements that advance the interests of the world's most powerful corporations at the expense of people and the environment.

24 See website of La Via Campesina, the international peasant movement: http://viacampesina.org/ See also, Jan Douwe van der Ploeg, *The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization*, Earthscan: London, 2008.

25 Jan Douwe van der Ploeg, *The New Peasantries: Struggles for Autonomy and Sustainability in an Era of Empire and Globalization*, Earthscan: London, 2008.

26 Joachim von Braun, Director General, International Food Policy Research Institute, "High and Rising Food Prices," presentation made to U.S. A.I.D., Washington, D.C., April 11, 2008. http://www.ifpri.org/presentations/20080411jvbfoodprices.pdf

27 International Union for the Protection of New Varieties of Plants (UPOV), "PVP Statistics for the period 2003-2007," Document prepared by the office of UPOV, October 19, 2008. http://www.upov.int

28 See website of the RUAF Resource Centres on Urban Agriculture and Food Security: http://www.ruaf.org/node/513

29 William Rees, "Why Urban Agriculture," Notes for the IDRC Development Forum on Cities Feeding People: A Growth Industry, Vancouver, BC, 20 May, 1997. Published by City Farmer, Canada's Office of Urban Agriculture.

30 *Ibid.*

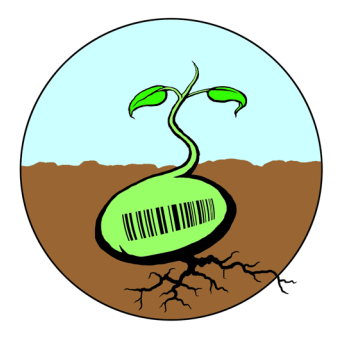
31 RUAF Resource Centres on Urban Agriculture and Food Security: http://www.ruaf.org/node/513

32 *Ibid.*

# Corporate Farm Inputs: Seeds, Agrochemicals, Fertilizers

## Seed Industry

### World's Top 10 Seed Companies



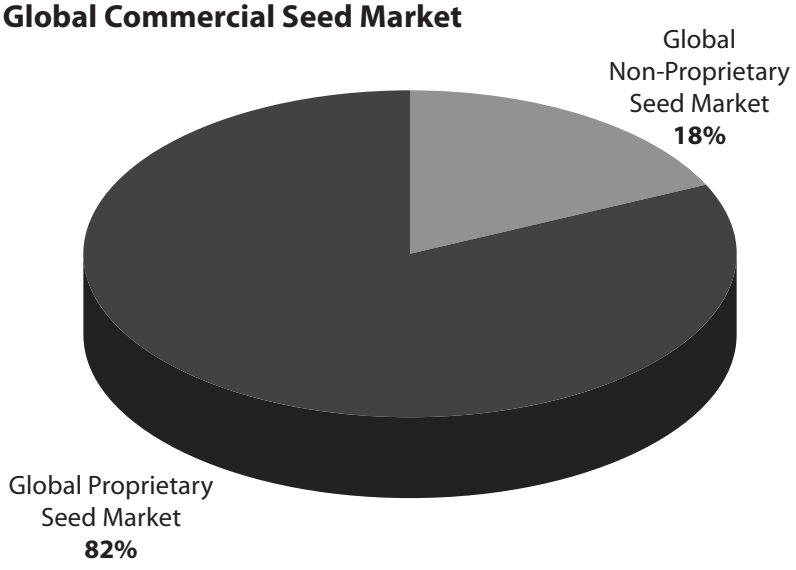
| Company | 2007 seed sales (US$ millions) | % of global proprietary seed market |
|---|---|---|
| 1. Monsanto (US) | $4,964 | 23% |
| 2. DuPont (US) | $3,300 | 15% |
| 3. Syngenta (Switzerland) | $2,018 | 9% |
| 4. Groupe Limagrain (France) | $1,226 | 6% |
| 5. Land O' Lakes (US) | $917 | 4% |
| 6. KWS AG (Germany) | $702 | 3% |
| 7. Bayer Crop Science (Germany) | $524 | 2% |
| 8. Sakata (Japan) | $396 | <2% |
| 9. DLF-Trifolium (Denmark) | $391 | <2% |
| 10.Takii (Japan) | $347 | <2% |
| **Top 10 Total** | **$14,785** | **67%** |

Source: ETC Group

**Commercial Seed Market:** In the first half of the 20th century, seeds were overwhelmingly in the hands of farmers and public-sector plant breeders. In the decades since then, Gene Giants have used intellectual property laws to commodify the world seed supply – a strategy that aims to control plant germplasm and maximize profits by eliminating Farmers' Rights. Today, the proprietary seed market accounts for a staggering share of the world's commercial seed supply. In less than three decades, a handful of multinational corporations have engineered a fast and furious corporate enclosure of the first link in the food chain.

According to Context Network, the proprietary seed market (that is, brand-name seed that is subject to exclusive monopoly – i.e., intellectual property), now accounts for 82% of the commercial seed market worldwide. In 2007, the global proprietary seed market was US$22,000 million. (The total commercial seed market was valued at $26,700 million in 2007.)[1] The commercial seed market, of course, does not include farmer-saved seed.

### Global Commercial Seed Market



According to ETC Group's ranking:

► **The top 10 seed companies account for $14,785 million – or two-thirds (67%) of the global proprietary seed market.**[2]

► **The world's largest seed company, Monsanto, accounts for almost one-quarter (23%) of the global proprietary seed market.**

► **The top 3 companies (Monsanto, DuPont, Syngenta) together account for $10,282 million, or 47% of the worldwide proprietary seed market.** ETC Group conservatively estimates that the top 3 seed companies control 65% of the proprietary maize seed market worldwide, and over half of the proprietary soybean seed market.[3]

*In less than three decades, a handful of multinational corporations has engineered a fast and furious corporate enclosure of the first link in the food chain.*

**Seed Industry Trends:**

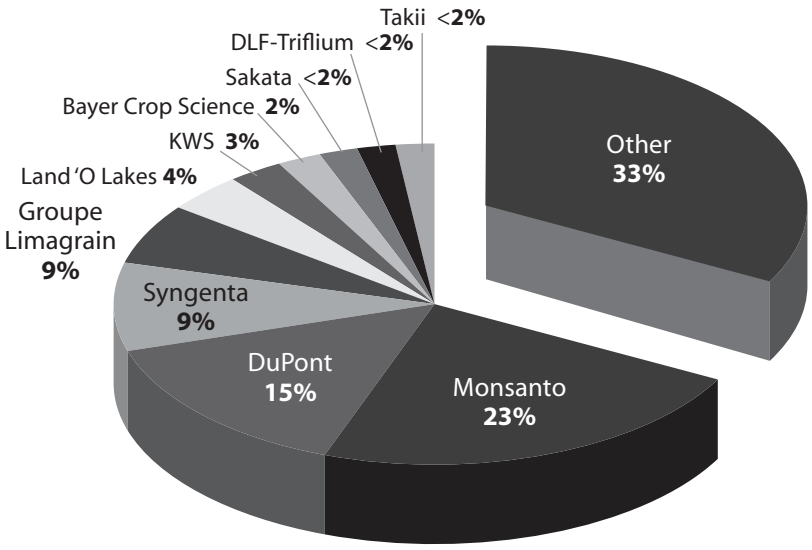
► Windfall Profits Amid World Food Emergency

► Tech Cartel: Gene Giants Forge "Cross-Enabling" Agreements

► Maximizing Monopoly: GE Seed Trait stacking

► Mantra *du jour*: GE crops are essential technology to combat food emergency and cure-all for climate chaos.

## Top 10 Share of Global Proprietary Seed Market




The top 10 seed companies account for 67% of the global proprietary seed market.

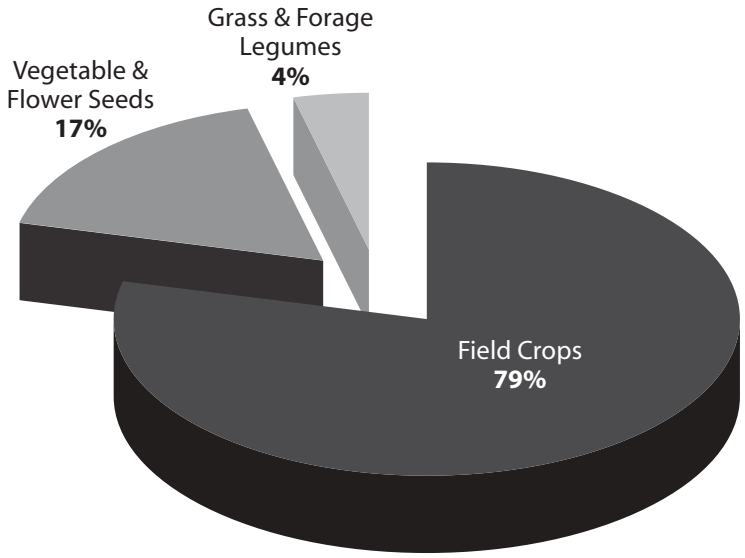
In 2008, as the global food crisis deepens, the world's largest seed companies are awash in profits. Record-high commodity prices and depleted grain reserves translate to soaring demand for seeds and other farm inputs (fertilizers, pesticides, farm equipment, etc.). Monsanto's 3rd quarter profits jumped 42% in June 2008. The *Wall St. Journal* noted that the seed giant is already raising seed prices "to capitalize on the planting boom it expects next year."[4]

**Global Proprietary Seed Market: Overview**

For the top 3 companies, genetically engineered seeds account for a steadily growing proportion of revenues.

Based on industry statistics, ETC Group estimates that Monsanto's bio-

## Global Proprietary Seed Market, 2007



tech seeds and traits (including those licensed to other companies) accounted for 87% of the total world area devoted to genetically engineered seeds in 2007.[5] The company claims that it licenses its biotech traits to an additional 250 companies. In 2007, almost half (48%) of DuPont's seed revenue came from products that carried a biotech trait.[6] UK consultancy firm, Cropnosis, puts the global value of GM crops in 2007 at $6.9 billion.[7]

**Gene Giant's Tech Cartel: Cross-Enabling Agreements:** Anti-trust regulators (anyone out there?) in Brussels and Washington take note: The Gene Giants are forging unprecedented alliances that render competitive markets a thing of the past. By agreeing to cross-license proprietary germplasm and technologies, consolidate R&D efforts and terminate costly IP litigation, the world's largest agrochemical and seed firms are reinforcing top-tier market power for mutual benefit. The trend isn't new, but the tech cartel deals are getting bigger and bolder. In March 2007 the world's largest seed company (Monsanto) and the world's largest chemical corporation (BASF) announced a $1.5 billion R&D collaboration to increase yields and drought tolerance in maize, cotton, canola and soybeans. ETC Group refers to this kind of partnership as a "non-merger merger"[8] – all the benefits of consolidation and oligopoly markets without the anti-trust constraints. Industry analysts expect the agreements to have "lasting repercussions throughout the seed, biotech and crop protection industries."[9] Although the Gene Giants insist that farmers will benefit from the tech cartel agreements (see box below), there's no doubt that customers will pay higher prices for fewer options and less innovation in the marketplace. Last year, even *Nature Biotechnology* opined the stunningly obvious: "The GM business looks like it's turning into a battle for giants only."[10]

**Maximizing Monopoly – Genetic Trait-Stacking:** Agbiotech has always been a package deal: Delivery of a seed's proprietary biotech traits depends on sales of the company's companion chemical. Biotech's most lucrative technical achievement is the engineering of crops to withstand a shower of chemical weed killers. Today, over 80% of the worldwide area devoted to genetically engineered crops carries at least one genetic trait for herbicide tolerance.[15]

After a dozen years on the market, biotech has delivered only two genetic traits to market – herbicide tolerance and insect resistance. But some GE varieties combine more than one of these traits in a single seed. For example, Monsanto's "triple-stack" biotech maize contains two insecticidal genes (one to resist corn borer and another to resist root worm) and herbicide tolerance (to withstand spraying of glyphosate – brand name: Round Up). From industry's point of view, two or three biotech traits are a lot better than one because double and triple stacked traits generate nearly twice the profitability.[16]

Monsanto introduced its first double-stack trait variety in 1998, and its first triple-stack trait hit the market in 2005.[17] A Monsanto spokesman told *Progressive Farmer* that 76% of the maize seed it sells in the U.S. in 2009 will be triple-stack varieties.[18] Syngenta aims to make triple-stack maize account for 85% of its portfolio by 2011.[19] In the U.S. – where half of the world's GE crops are grown – 37% of all transgenic crops contained two or three biotech traits in 2007. Whether farmers want the premium-priced, fully-loaded stacked traits or not, they may have

### Sample Tech Cartel Agreements

**Monsanto** (the world's largest seed company) and **BASF** (the world's #3 agrochemical firm) announce colossal $1.5 billion R&D collaboration involving 60/40 profit-sharing, respectively. *"This is a great step forward in bringing to farmers higher yielding crops…"*[11] BASF & Monsanto, joint news release (March 2007)

**Monsanto** & **Dow Agrochemicals** join forces to develop the first-ever genetically engineered maize loaded with eight genetic traits, for release in 2010. *"Farmers will have more product choices to optimize performance and protection…"* – Dow news release (Sept. 2007)[12]

**Monsanto** and **Syngenta** agree to call a truce on outstanding litigation related to global maize and soybean interests, and forge new cross-licensing agreements. *"We're pleased … to put farmer customers first and reach an agreement that offers them tremendous benefits and choice in the seasons ahead."*[13] – Monsanto news release (May 2008)

**Syngenta** & **DuPont** announce an agreement that will broaden each company's pesticide product portfolios. *"These products, which are highly complementary to our portfolio and pipeline, will provide additional options for growers..."*[14] – DuPont & Syngenta, joint news release (June 2008)

little choice in the future. Monsanto and Dow Agrosciences joined forces in 2007 to develop maize seeds with up to eight genetic traits (two kinds of herbicide tolerance and six genes for insect resistance) for release in 2010.

*"The lack of competition and innovation in the marketplace has reduced farmers' choices and enabled Monsanto to raise prices unencumbered."*

*– Keith Mudd, Organization for Competitive Markets, following Monsanto's decision to raise some GE maize seed prices by 35%, July 2008* [22]

At a July 2008 meeting, Monsanto officials announced plans to raise the average price of some of the company's triple-stack maize varieties a whopping 35 percent.[20] Fred Stokes of the U.S.-based Organization for Competitive Markets (OCM) describes the implications for farmers: "A $100 price increase is a tremendous drain on rural America. Let's say a farmer in Iowa who farms 1,000 acres plants one of these expensive corn varieties next year. The gross increased cost is more than $40,000. Yet there's no scientific basis to justify this price hike. How can we let companies get away with this?"[21]

The U.S. government is currently subsidizing sales of Monsanto's triple-stack maize seed by offering lower crop insurance premiums to farmers who plant it on non-irrigated land –because the biotech maize reportedly provides lower risk of reduced yields when compared to conventional hybrids.[23] The pilot project, which began in 2008, is especially specious because the U.S. government relied on data from Monsanto to substantiate the claim.[24]

**Corporate Grab on Climate Genes:** Agbiotech's newest public relations campaign puts a fresh twist on a stale theme: GE crops as the cure-all technology that will increase production and feed the world. This time, GE crops are touted as the solution to the current food crisis and climate change (and peak oil). (The Biotechnology Industry Organization's current slogan is *"Heal, fuel, feed the world."*) The Gene Giants are stockpiling hundreds of monopoly patents on genes in plants that the companies will market as crops genetically engineered to withstand environmental stresses such as drought, heat, cold, floods, saline soils and more. ETC Group's May 2008 report, "Patenting the Climate Genes," reveals that Monsanto, BASF, DuPont, Syngenta, Bayer and Dow (and their biotech partners) have filed 532 patent documents on so-called "climate ready" genes at patent offices around the world.[25] The 532 documents represent 55 patent families (corresponding to a single "invention" submitted for patent monopoly in more than one country). Together, six of the world's largest agrochemical and seed


Patented gene technologies will not help small farmers survive climate change, but they will concentrate corporate power, drive up costs, inhibit public sector research and further undermine the rights of farmers to save and exchange seeds.

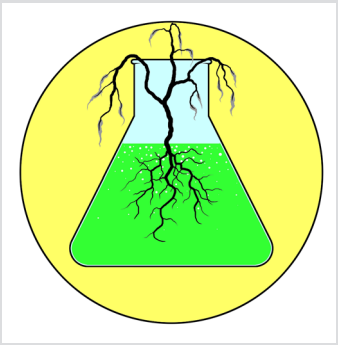
corporations (BASF, Monsanto, Bayer, Syngenta, DuPont and Dow) account for 42 of the 55 patent families (79%). These six companies collectively control around half of the proprietary seed market, and 75% percent of the global agrochemical market.

The Gene Giants aim to convince governments, farmers and reluctant consumers that genetic engineering is the essential adaptation strategy to insure agricultural productivity in the midst of climate change. According to Monsanto, "everyone recognizes that the old traditional ways just aren't able to address these new challenges" – so the only hope is "climate ready" GM crops.[26]

A decade ago, ETC Group noted that seed industry giants were turning to "advanced genomics" to identify and control key crop genes and their link to agronomically important traits. "The danger," we wrote, "is that a handful of companies will secure a virtual high-tech stranglehold on plant germplasm at the molecular level."[27] Unfortunately, we got that right.

**Bottom line:** So-called climate-ready genes are a false solution to climate change. Patented gene technologies will not help small farmers survive climate change, but they will concentrate corporate power, drive up costs, inhibit public sector research and further undermine the rights of farmers to save and exchange seeds.

## World's Top 10 Pesticide Firms



| Company | Agrochemical Sales 2007 (US$ millions) | % Market Share |
|---|---|---|
| 1. Bayer (Germany) | $7,458 | 19% |
| 2. Syngenta (Switzerland) | $7,285 | 19% |
| 3. BASF (Germany) | $4,297 | 11% |
| 4. Dow AgroSciences (USA) | $3,779 | 10% |
| 5. Monsanto (USA) | $3,599 | 9% |
| 6. DuPont (USA) | $2,369 | 6% |
| 7. Makhteshim Agan (Israel) | $1,895 | 5% |
| 8. Nufarm (Australia) | $1,470 | 4% |
| 9. Sumitomo Chemical (Japan) | $1,209 | 3% |
| 10. Arysta Lifescience (Japan) | $1,035 | 3% |
| **Total** | **$34,396** | **89%** |

Source: Agrow World Crop Protection News, August 2008

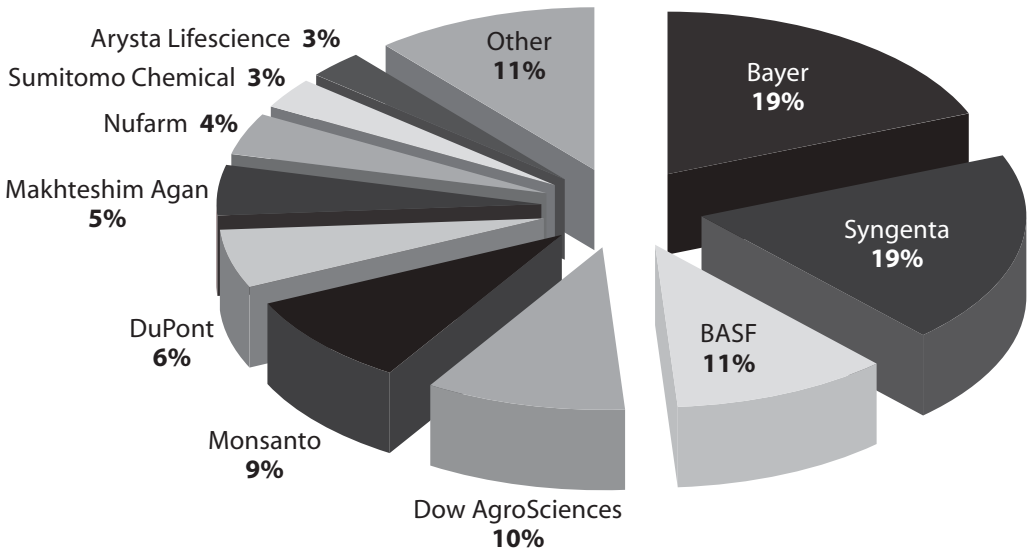
The top 10 companies control 89% of the global agrochemical market.

The worldwide market for agrochemicals was US$38.6 billion in 2007 – up 8.4% over the previous year. The top 6 companies accounted for $28.8 billion, or 75% of the total market.

**Symbiotic Sales:** The world's six largest agrochemical manufacturers are also seed industry giants. Despite skyrocketing fuel and fertilizer costs, high grain prices created soaring demand for commercial seeds and pesticides in 2007. After two decades of sagging sales, the world's largest pesticide companies rebounded last year – in large part due to the subsidy-driven boom in agrofuel crops.

In 2007 the four largest pesticide companies (Bayer, Syngenta, BASF, Dow) reported double-digit sales jumps. Pesticide revenues are up in nearly all

### Global Agrochemical Market 2007 Sales



regions, but Latin America (particularly Brazil, Argentina and Mexico) and Eastern Europe were the key growth markets. Still glowing from his company's stellar performance in 2007, the CEO of BASF Plant Science estimates that by 2025 the global agrochemical market will be worth $US50 billion.[32]

**Exterminating the Pollinators:** In recent years, beekeepers around the world have seen massive die-offs of honeybees, a phenomenon dubbed "colony collapse disorder." The demise of honeybees and wild pollinators has been blamed on cell phones, genetic uniformity of honeybees, mites, pathogens, nutrition deficit, genetically engineered crops, and, of course, pesticides.

Although a combination of factors may be involved, one of the chief culprits is a family of pesticides known as neonicotinoids – a neurotoxin that impacts the central nervous system of insects. Bayer CropScience markets a number of chemicals in this family – including clothianidin and imidacloprid – which are widely used as seed coatings to protect maize and canola seedlings from pests. In 1999, France first banned sales of some of Bayer's neonicotinoid-based pesticides after they were linked to honeybee deaths. In May 2008 Germany suspended sales of the same chemical family. Slovenia and Italy have since followed suit. According to German authorities: "It can unequivocally be concluded that a poisoning of the bees is due to the rub-off of the pesticide ingredient clothianidin from corn seeds."[33]

Some suspect that neonicotinoid-based pesticides could be a potential trigger for viral infection in honeybees or responsible for impairing the honeybee's immune defenses. In August 2008 the Natural Resources Defense Council filed a lawsuit against the U.S. Environmental Protection Agency for its failure to release records on clothianidin's toxicity to bees.

In response to the German suspension, Bayer is quick to point the finger at applicators who are misusing its products. The company said that it is developing standards to "avoid incorrect use of seed treatment products in the future."[34]

*The world's six largest agrochemical manufacturers are also seed industry giants.*

**Mind the Gap:** Weed killers account for about one-third of the global pesticide market, and agrochemical giants are ratcheting up R&D on new herbicides and herbicide-tolerant genes. Monsanto's glyphosate-resistant (Roundup Ready) crops have reigned supreme on the biotech scene for over a decade – creating a near-monopoly for the company's Roundup Ready herbicide – which is now off patent. According to *Chemical & Engineering News*, BASF, Syngenta, Bayer, Dow and DuPont are competing to fill "the glyphosate gap"[35] – a gap that's growing fast because at least 14 weed species on five continents have developed resistance due to massive applications of glyphosate.[36] As a result, farmers must employ more toxic chemicals to kill the resistant weeds.[37] Commonly known as the "pesticide treadmill," it's a classic case of chasing a new techno-fix to mop up the mess of an older, failed technology. Agrochemical giants prefer to describe the resistance problem as a business opportunity: In the words of Syngenta's Crop Science CEO, John Atkin: "Resistance is actually quite healthy for our market, because we have to innovate."[38]

## World's Biggest Fertilizer Companies


| Company | 2007 Net Income (US$ millions) |
|---|---|
| 1. PotashCorp (Canada) | 1,104 |
| 2. Yara (Norway) | 1,027 |
| 3. Mosaic (USA) (Cargill has 55% stake) | 944 |
| 4. Israel Chemicals Ltd. (Israel) | 461 |
| 5. Agrium (Canada) | 441 |
| 6. K+S Group (Germany) | 303 |
| 7. Sociedad Quimica y Minera (Chile) | 165 |

Source: PotashCorp, 2007 .

**Fertile Ground for Profit:** Recent increases in grain plantings – to feed livestock and cars – means increased consumption of chemical fertilizers – and that means higher energy use. Fertilizer production and use accounts for about 30 percent of energy use in U.S. agriculture, where nearly half the fertilizer consumed is applied to maize.

Globally, consumption of industrial fertilizers increased by 31% from 1996 to 2008 due to increases in livestock production and agrofuel crop plantings.[39] Prices are skyrocketing: The cost of fertilizer increased from $245 per ton in January 2007 to $1,600 per ton in August 2008.[40]

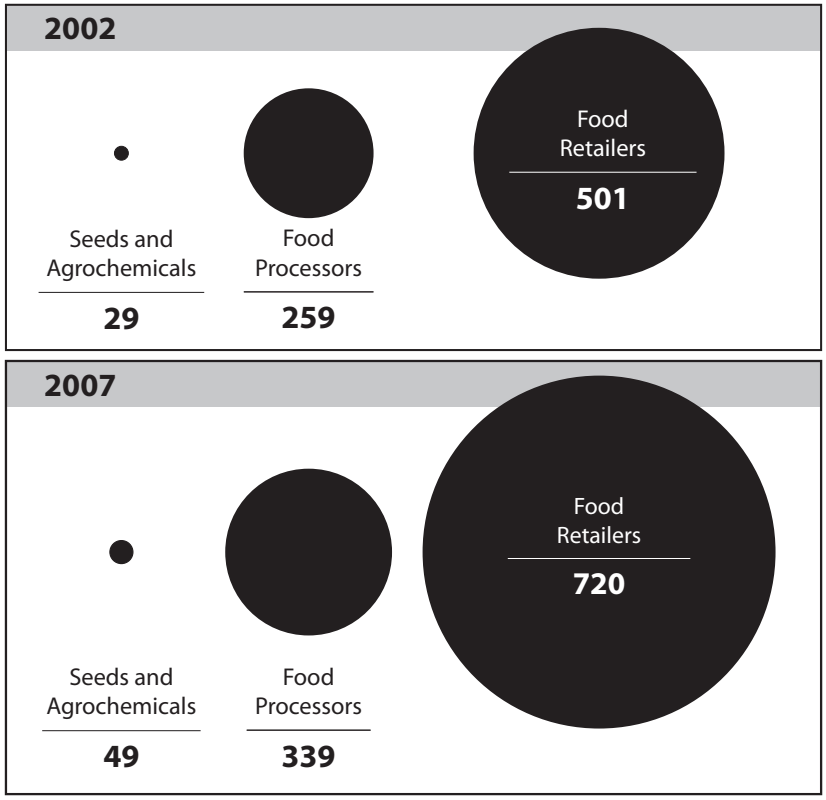
According to Canada-based PotashCorp, the largest fertilizer company in the world, it takes 7 kilograms (kg) of feed grain to produce every 1 kg of beef and 4 kg of grain to produce 1 kg of pork. One kg of poultry represents 2 kg of grain.[41] But fertilizer use is highly inefficient and wasteful. Only about 6 percent of nitrogen used in raising cows, for example, ends up in their meat – the remainder seeps into air or water supplies.[42] Only 35 percent of the fertilizers used to produce milk, eggs and grain are absorbed in the final product. The environmental costs of fertilizer run-off are staggering. A recent study identifies approximately 400 coastal "dead zones" around the globe, covering an area of 245,000 $km^2$.[43] These are marine waters that are so oxygen-depleted they can no longer sustain life. The main culprit: chemical fertilizer runoff.

**Peak Phosphate?** The three primary ingredients (macro-nutrients) contained in industrial fertilizers are nitrogen, phosphate and potassium. Supplies of phosphate, a "finite and irreplaceable" mineral, are highly concentrated in a handful of countries.[44] Analysts who are tracking supplies of phosphate rock are now predicting "potentially catastrophic future shortage of phosphorus."[45] According to the Global Phosphorus Research Initiative (GPRI) supplies of high-quality phosphate are already decreasing and known reserves of phosphate will be depleted in 50-100 years. The price of phosphate rock rose seven-fold in a 14 month period between January 2006 and April 2008.[46] Morocco and Western Sahara account for 32% of global phosphate reserves; China accounts for 37% of world reserves. In April 2008 China imposed a 135 percent tariff on phosphate rock exports in an attempt to secure domestic supplies. The move alarmed the fertilizer industry, as well as Western Europe and India, which are both entirely dependent on phosphorus imports.[47]

*Fertilizer production and use accounts for about 30% of energy use in U.S. agriculture, where nearly half the fertilizer consumed is applied to maize.*

**Corporate Food Chain At-a-Glance: Top 10 Revenue Share**

($US billions)




Source: ETC Group. *Note: In 2002, Wal-Mart did not report grocery sales separate from total revenues. For purposed of comparison, we estimate that 40% of Wal-Mart's 2002 revenues were derived from grocery sales. In 2007, grocery sales accounted for 46% of Wal-Mart's sales.*

*"Whilst there is not enough reliable data today to predict the exact year peak phosphorus will occur, what is clear is that discussion on alternative phosphorus sources and governance models is required now to ensure that the world's farmers have sufficient access to phosphorus fertilizers in the long-term to feed humanity, without compromising the environment, livelihoods and economies."*

*– Global Phosphorous Research Initiative*

## Notes

1 According to estimates provided by industry analysts, Context Network, the value of the *overall commercial seed market* was $26,700 million in 2007, (including seeds purchased from public breeding programs). That's a 14% increase ($3.8 billion) over 2006 seed industry revenues. We estimate that top 10 companies account for 55.4% of the overall commercial seed market. According to the Context Network, the global proprietary seed market was US$22,000 million in 2007, a 10% increase over 2006.

2 ETC Group assumes that virtually all of the seed revenues from the top 10 seed companies are derived from proprietary seed products.

3 Estimate based on Syngenta's 2005 report, using Context Network data, 2005.

4 Scott Kilman, "Monsanto Posts 42% Jump in Net Grain Rally Boosts 3rd-Quarter," *Wall Street Journal*, June 26, 2008.

5 The statistic is based on Monsanto's Preliminary Biotechnology Trait Acreage: FY 1996-2008F, www.monsanto.com and ISAAA's calculation of total biotech crop area of 114.3 million hectares in 2007. February 13, 2008. www.isaaa.org

6 Personal communication with Pioneer/DuPont.

7 According to Context Network, the global value of the proprietary seed+trait market was $8.8 billion in 2007 – or 40% of the proprietary seed market worldwide. Note that Context Network's estimate includes farm-saved GM seeds in Argentina/Brazil and India. It also includes non-GM trait+seed (e.g. Clearfield).

8 ETC Group, "The Five Gene Giants are Becoming Four – Dupont & Monsanto: Living in Sinergy?" 9 April 2002. http://www.etcgroup.org/en/materials/publications.html?pub_id=215

9 "Context Network, "Thinking in Context.." April 2008. www.contextnet.com

10 Peter Mitchell, "GM giants pair up to do battle," *Nature Biotechnology* 25, 695 - 696 (2007)

11 http://monsanto.mediaroom.com/index.php?s=43&item=470

12 http://www.dowagro.com/newsroom/corporatenews/2007/20070914a.htm

13 http://monsanto.mediaroom.com/index.php?s=43&item=604

14 http://tinyurl.com/59nrmx

15 www.isaaa.com This statistic includes GE varieties that may contain more than one engineered trait.

16 http://seekingalpha.com/article/28652-syngenta-planting-the-seeds-of-growth

17 http://www.monsanto.com/pdf/investors/2006/02-14-06a.pdf

18 Marcia Zarley Taylor, "Minding Ag's Business," *DTN Progressive Farmer*, July 3, 2008. http://www.dtnprogressivefarmer.com

19 AGROW, "Syngenta Interview: John Atkin," May 30, 2008. http://www.agropages.com/resources/feature/featureinfo.aspx?News_id=1213

20 Marcia Zarley Taylor, "Minding Ag's Business," *DTN Progressive Farmer*, July 3, 2008. http://www.dtnprogressivefarmer.com

21 Organization for Competitive Markets, News Release, "Monsanto Corn Seed Price Hikes a Threat to Agriculture," July 24, 2008. http://www.competitivemarkets.com

22 *Ibid.*

23 See USDA website, frequently asked questions about Biotech Yield Endorsement, October 9, 2007. http://www.rma.usda.gov/help/faq/bye.html

24 *Ibid.*

25 *ETC Group Communiqué*, "Patenting the 'Climate Genes'...and Capturing the Climate Agenda," May/June 2008, http://www.etcgroup.org/en/materials/publications.html?pub_id=687

26 Rick Weiss, "Firms Seek Patents on 'Climate Ready' Altered Crops," *Washington Post*, 13 May 2008, p. A04.

27 *ETC Group Communiqué*, "Seed Industry Consolidation: Who Owns Whom?" July/August 1998. http://www.etcgroup.org/en/materials/publications.html?pub_id=404

28 Phillips McDougall cited in Agrow World Crop Protection News, Wednesday, 12 December 2007. http://www.agrow.com/news154.shtml

29 BASF has only minor seed interests, but its $1.5 billion R&D agreement with Monsanto means that it is part of this group. Dow is not a top 10 seed company – but it is a significant player.

30 Melody Voith. "BASF Is Betting On The Farm," *Chemical & Engineering News*, May 26, 2008, Vol. 86, No. 21, pp. 24-25.

31 Patricia Short, "An Agchem Rebound," *Chemical & Engineering News*, October 1, 2007. Vol. 85, No. 40, pp. 23-25.

32 Agropages.com, "Crop Protection in 2008," June 30, 2008. http://www.agropages.com/resources/feature/featureinfo.aspx?News_id=1285

33 Sarah Everts, "Honeybee Loss: Germany suspends use of clothianidin after the pesticide is linked to honeybee deaths," *Chemical & Engineering News*, May 21, 2008.

34 Bayer News Release, May 20, 2008. http://www.bayercropscience.com/BCSWeb/CropProtection.nsf/id/20080520_EN_1

35 Melody Voith, "BASF Is Betting On The Farm," *Chemical & Engineering News*, May 26, 2008, Vol. 86, No. 21, pp. 24-25.

36 Weed Science Society of America monitors the evolution of herbicide-resistant weeds and assesses their impact. Database of resistant weeds: http://www.weedscience.org/Summary/UspeciesMOA.asp?lstMOAID=12

37 Instead of using glyphosate (Round-Up), farmers are being advised to use far more dangerous weedkillers such as paraquat, 2-4-D and atrazine.

38 Agropages.com, "Syngenta Interview: John Atkin," May 30, 2008. http://www.agropages.com/resources/feature/featureinfo.aspx?News_id=1213

39 Keith Bradsher and Andrew Martin, Shortages Threaten Farmers' Key Tool: Fertilizer," *The New York Times*, 30 April 2008.

40 "Multi-billion Dollar Fertilizer Facility For Ghana," *Daily Guide*, August 18, 2008. http://dailyguideghana.com/portal/modules/news/article.php?storyid=6720

41 PotashCorp, *Overview of Potash-Corp and its Industry* 2008, p. 13.

42 Richard Morgan, "Beyond Carbon: Scientists Worry About Nitrogen's Effects," *New York Times*, September 2, 2008.

43 Robert J. Diazl and Rutger Rosenberg, "Spreading Dead Zones and Consequences for Marine Ecosystems," *Science*, 15 August 2008: Vol. 321. no. 5891, pp. 926 – 929. Abstract available at: www.sciencemag.org. See also, Bina Venkataraman, "Ocean 'Dead Zones' on the Rise, The New York Times, 14 August 2008.

44 Mario Osava, "Farming Faces Phosphate Shortfall," *Energy Bulletin*, October 15, 2007. http://www.energybulletin.net/node/35851

45 Leo Lewis, "Scientists warn of lack of vital phosphorus as biofuels raise demand," *Times* (UK), June 23, 2008.

46 See website of the Global Phosphorus Research Initiative (GPRI): http://phosphorusfutures.net

47 Leo Lewis, "Scientists warn of lack of vital phosphorus as biofuels raise demand," *Times* (UK), June 23, 2008.

48 Stuart White and Dana Cordell, "Peak Phosphorous: The Sequel to Peak Oil," The Story of P Information Sheet, 2008. http://phosphorus-futures.net/files/2_Peak%20P_SWhite_DCordell.pdf

# Corporate Food Outputs: Food & Beverage Manufacturing; Global Grocery Retailers

## Food & Beverage Manufacturing Industry

### World's Top 10 Food & Beverage Corporations


| Company | 2007 Food & Beverage Sales (US$ millions) | Total Sales (US$ millions) | Food & Bev as % of Total Sales |
|---|---|---|---|
| 1. Nestle (Switzerland) | 83,600 | 89,700 | 93 |
| 2. PepsiCo, Inc. (USA) | 39,474 | 39,474 | 100 |
| 3. Kraft Foods (USA) | 37,241 | 37,241 | 100 |
| 4. The Coca-Cola Company (USA) | 28,857 | 28,857 | 100 |
| 5. Unilever (The Netherlands) | 26,985 | 50,235 | 54 |
| 6. Tyson Foods (USA) | 26,900 | 26,900 | 100 |
| 7. Cargill (USA) | 26,500 | 88,266 | 30 |
| 8. Mars (USA) | 25,000 | 25,000 | 100 |
| 9. Archer Daniels Midland Company (USA) | 24,219 | 44,018 | 55 |
| 10. Danone (France) | 19,975 | 19,975 | 100 |
| **Total Top 10** | **338,751** | **449,666** | |

Source: Leatherhead Food International, 2008

The top 10 food and beverage firms control 26% of the global market for packaged food products – a 14% increase since 2004.[1] Leatherhead Food estimates that global sales of packaged foods reached $1.3 trillion in 2007.[2]

The top 10 account for 35% of the revenue earned by the world's top 100 food & beverage companies. According to Leatherhead Food, the top 100 food and beverage firms had combined food revenues of $966 billion in 2007.

The top 100 food and beverage companies accounted for three-quarters (74%) of all packaged food products sold worldwide in 2007 – a 17% increase in market share since 2004.

Even in a sputtering economy, the appetite for food industry mergers and acquisitions continues. The U.S.-based Food Institute tracked 413 food processing industry mergers and acquisitions in 2007 – up from 392 deals in 2006. Recent mega-mergers include:

**Beef Barons:** The world's largest beef packer, Brazil's JBS S.A., is acquiring U.S.-based Smithfield Foods' beef unit for $565 million – a move that would give five corporations 85% of the U.S. beef processing market. But just when we thought markets couldn't get more consolidated, JBS is making a $560 million bid to takeover U.S.-based National Beef for $560 million, positioning just three major companies to control the market. U.S. anti-trust regulators announced in October 2008 that they will try to block the deal.

**Beer Barons:** Belgian-Brazilian brewer, InBev, swallowed U.S. beer giant Anheuser-Busch for $52 billion in July 2008 – and now controls a quarter of the global market. The merger follows SABMiller's 2007 merger of its U.S. operations with MolsonCoors – to create Miller/Coors.

**Baby Food Barons:** In 2007, Group Danone paid $17 billion to buy Dutch baby-food maker, Numico; Nestlé acquired Gerber, the baby food business owned by Novartis, for $5.5 billion.

**Biscuit Barons:** In 2007, Kraft Foods (USA) acquired the global biscuit business of Groupe Danone (France) for $7.2 billion.

**Candy Kings:** Mars Incorporated (maker of Snickers and Skittles and M&Ms) purchased Wm. Wrigley Jr. Co. (chewing gum) for $23 billion knocking the UK's Cadbury PLC from the top candy-making slot.

## World's Top 10 Global Food Retailers

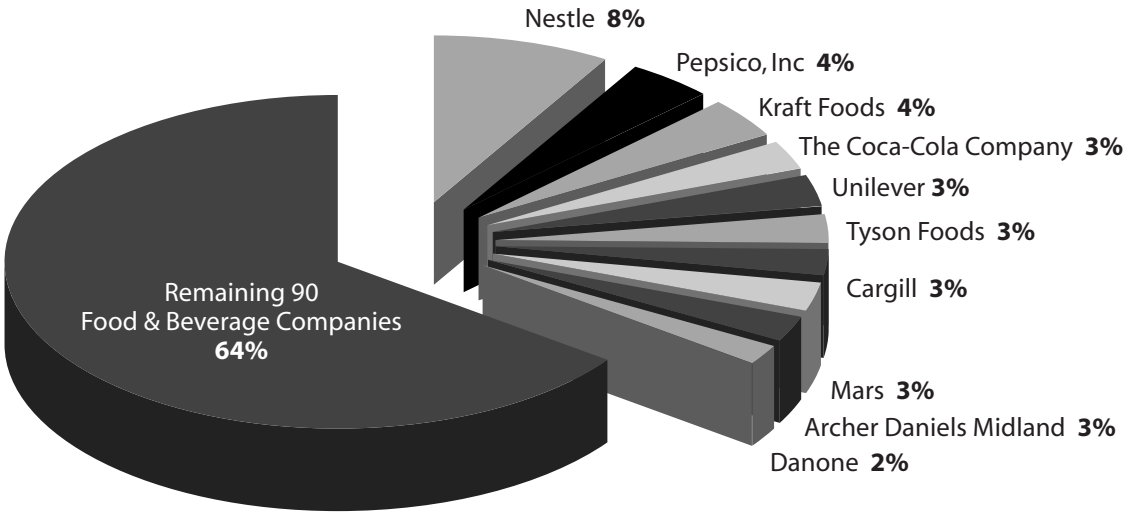
| Company | 2007 Food Sales (US$ millions) | 2007 Total Sales (US$ millions) | Grocery as % of Total Sales |
|---|---|---|---|
| 1. Wal-Mart (US) | 180,621 | 391,135 | 46 |
| 2. Carrefour (France) | 104,151 | 141,087 | 74 |
| 3. Tesco (UK) | 72,970 | 100,200 | 73 |
| 4. Schwarz Group (Germany) | 58,753 | 70,943 | 83 |
| 5. Aldi (Germany) | 55,966 | 65,251 | 86 |
| 6. Kroger (US) | 52,082 | 73,053 | 71 |
| 7. Ahold (UK) | 50,556 | 62,614 | 81 |
| 8. Rewe Group (Germany) | 49,651 | 56,324 | 88 |
| 9. Metro Group (Germany) | 49,483 | 73,538 | 71 |
| 10. Edeka (Germany) | 45,397 | 51,272 | 89 |
| **Total Top 10** | **719,630** | **1,085,417** | |

Source: Planet Retail

The top 100 global food retailers tracked by Planet Retail had combined grocery retail sales of $1.8 trillion in 2007 – 35% of all grocery retail sales worldwide. Wal-Mart accounts for 10% of the grocery revenues earned by the top 100, and 25% of the revenues earned by the top 10. The top 3 mega-grocery retailers – Wal-Mart, Carrefour and Tesco – account for 50% of the Top 10's revenues.

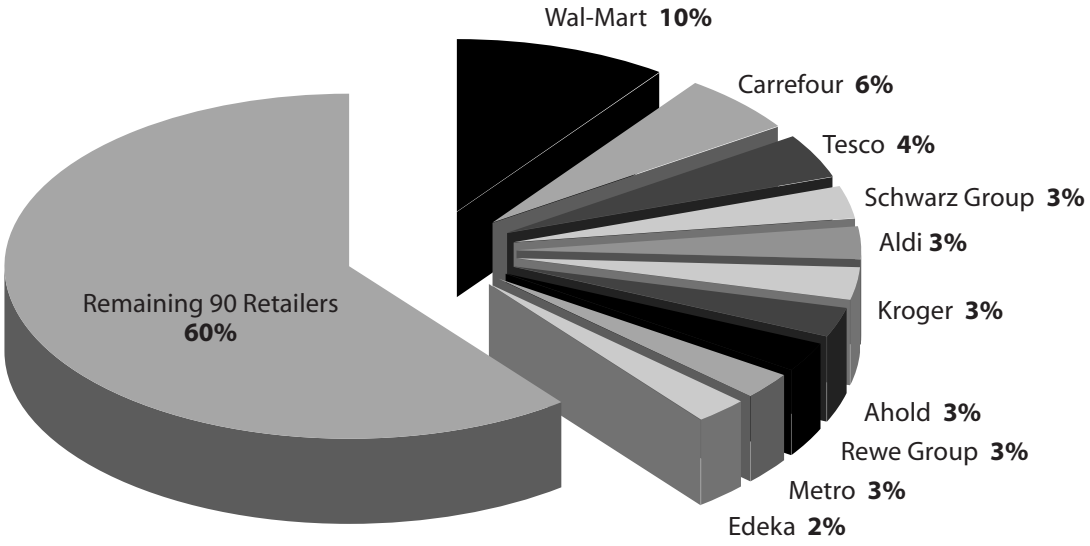
After decades of consolidation, giant grocery retailers occupy the most powerful position in the agro-industrial food chain. Wal-Mart isn't simply the largest grocery retailer; it's the planet's largest corporation. Operating in 13 countries, with revenues of $379 billion and over 2 million employees, Wal-Mart clings to the top spot on the global Fortune 500 – surpassing oil and auto behemoths like ExxonMobil, Shell, BP and Toyota.

### Global Food & Beverage Companies: Top 10 Account for 35% of Packaged Food Sold by Top 100




Food Sales by top 100 food and beverage firms in 2007 = $966 billion

## Global Food Retailers: Top 10 Account for 40% of Groceries Sold by Top 100




Grocery sales of top 100 retailers in 2007= US$1.8 trillion

Wal-Mart's purchasing power is so vast that it has been able to call the shots with suppliers and squeeze producers until they conform to the company's standards. As one Wal-Mart executive told *Fortune*, "When our grocery suppliers bring price increases, we don't just accept them."[4]

**Chain Reaction:** When the top of the food chain starts yanking, it's labor that suffers the biggest squeeze. When giant food retailers dictate lower prices, suppliers are forced to trim costs. That typically means lower wages and declining labor standards further down the food chain. Although farm commodities reached record-high prices in the first half of 2008, farmers also spent far more for seed, fertilizers and agrochemicals. Corporate concentration in farm inputs (seeds, pesticides, fertilizers, etc.) is far greater than in food processing and grocery retail markets, but the push for profits at the top drives down wages and working standards throughout the industrial food system – affecting farmers, farmworkers, processing plant workers as well as big-box retail employees (Squeezed on all sides, farmers receive a steadily shrinking share of every supermarket food dollar – averaging less than 20% in the USA, for example.)

But even Wal-Mart and the other titans atop the global food chain can't muscle their way out of higher grain and energy costs. In mid-2008, meat prices surged to a 22-year high due to record prices of livestock feed (soybean and corn).[5] Kraft Foods will reportedly raise food prices 12-13 percent in 2008.[6] Even retailers are beginning to feel the pinch: Safeway,

*After decades of consolidation, giant grocery retailers occupy the most powerful position on the agro-industrial food chain. Wal-Mart isn't simply the largest grocery retailer, it's the planet's largest corporation.*

Supervalu, Delhaize and Costco – all among the top 25 biggest grocery retailers – expect to bring in less revenue in 2008 than they projected at the end of last year.[7]

**Kinks in the Chain:** A tough economy also means heightened competition for turf on the moral high ground. 2008 has seen the Grocery Manufacturers Association, a lobby group representing the world's biggest food, beverage and consumer products companies – including Unilever, Coca-Cola, ConAgra, Nestle and PepsiCo – pleading on behalf of the environment and hungry people. The Association blames record food price inflation on the diversion of food crops to biofuel production. Agribusiness giants (e.g., Monsanto, DuPont, Archer Daniels Midland) are teaming up to counter such claims, forming a group whose name sounds like a bedtime story set in Utopia – "Alliance for Abundant Food and Energy." The alliance argues that, in the face of peak oil and peak soil, "we can grow our way to a solution" with new technologies, including genetically modified crops.[8]

## Notes

1 In Oligopoly, Inc. 2005, ETC Group reported that global sales of packaged foods in 2004 was $829 billion, an estimate provided by Leatherhead Foods. In 2007, Leatherhead estimates that global sales of packaged foods reached $1,310 billion.

2 Personal communication with Leatherhead Foods International.

3 ETC Group gratefully acknowledges data provided by analysts at Planet Retail. According to Planet Retail, grocery retail sales worldwide in 2007 were $5,143,000 million (more than $5.1 trillion). http://www.planetretail.com

4 Suzanne Kapner, "Wal-Mart puts the squeeze on food costs," *Fortune*, May 29, 2008. http://money.cnn.com/2008/05/28/magazines/fortune/kapner_walmart.fortune/index.htm

5 Elizabeth Rigby and Hal Weitzman, "US food groups plan hefty price rises," *Financial Times*, 20 July 2008. http://www.ft.com/cms/s/0/c245dc2c-5673-11dd-8686-000077b07658.html

6 *Ibid.*

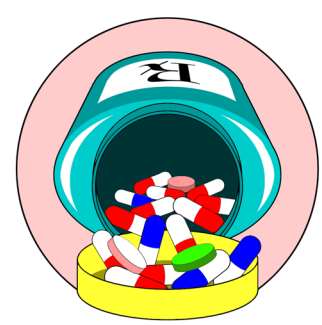
7 David Orgel, "Economic Storm Finally Crashes into Supermarkets," *Supermarket News*, 4 Aug 2008. http://supermarketnews.com/viewpoints/0804_economic_storm_finally/

8 USAgNet, "Alliance for Abundant Food and Energy Established," 31 July 2008, http://www.wisconsinagconnection.com/story-national.php?Id=1788&yr=2008. See also, Doug Cameron, "Agribusiness Group *Forms to Protect Ethanol Subsidies," Wall Street Journal*, 25 July 2008.

# Corporate Medicine & Health: Big Pharma, Biotech, Animal Pharmaceutical, Bioinformatics

## Pharmaceutical Industry

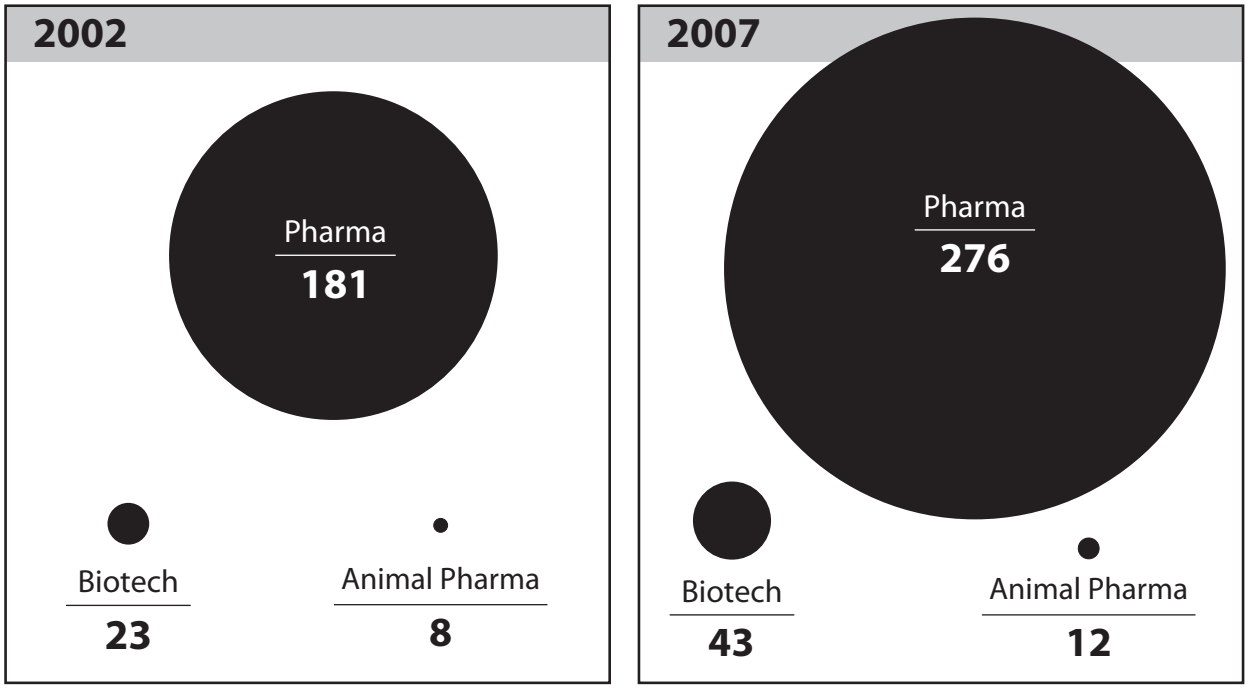
### World's Top 10 Pharmaceutical Companies



| Company | 2006 Sales (US$ millions) | Pharma sales as % of total sales | % share of total sales of top 100 companies |
|---|---|---|---|
| 1. Pfizer | 45,083 | 95.9 | 8.9 |
| 2. GlaxoSmithKline | 40,156 | 86.5 | 8.0 |
| 3. Sanofi-Aventis | 38,555 | 100 | 7.6 |
| 4. Roche | 27,290 | 79.2 | 5.4 |
| 5. AstraZeneca | 26,475 | 100 | 5.3 |
| 6. Johnson & Johnson | 23,267 | 43.6 | 4.6 |
| 7. Novartis | 22,576 | 62.7 | 4.5 |
| 8. Merck & Co. | 20,375 | 90 | 4.0 |
| 9. Wyeth | 16,884 | 83 | 3.4 |
| 10. Lilly | 15,691 | 100 | 3.1 |
| **Total** | **276,352** | | **54.8** |

Source: *Scrip 100, 2007/2008*

### Corporate Medicine & Health At-A-Glance: Top 10 Revenue Share (US$ billions)



The top 100 drug companies tracked by market analyst firm Scrip had combined pharmaceutical sales of $504 billion in 2006. The top 10 companies account for 55% of total sales.

For decades, big pharma's blockbuster business plan was to get bigger and bigger through major mergers and acquisitions – because two or three big-selling drugs were enough to sustain a large international workforce, pay obscene CEO salaries and still guarantee huge profits. But this year's top-10 list doesn't look much different from our 2005 list – the only recent mega-merger was Bayer's late 2006 acquisition of Schering AG to form Bayer Schering Pharma AG (#15). Analysts speculate that Bristol-Myers Squibb (#11) is now a prime takeover target.

Although most of the corporate names on this year's top 10 list are the same, these are turbulent times for Big Pharma: The drug development pipeline is still clogged; blockbusters are coming off-patent as fast as generic equivalents are flying off Wal-Mart's shelves; and regulators are yanking top-selling brands off the market for safety reasons.

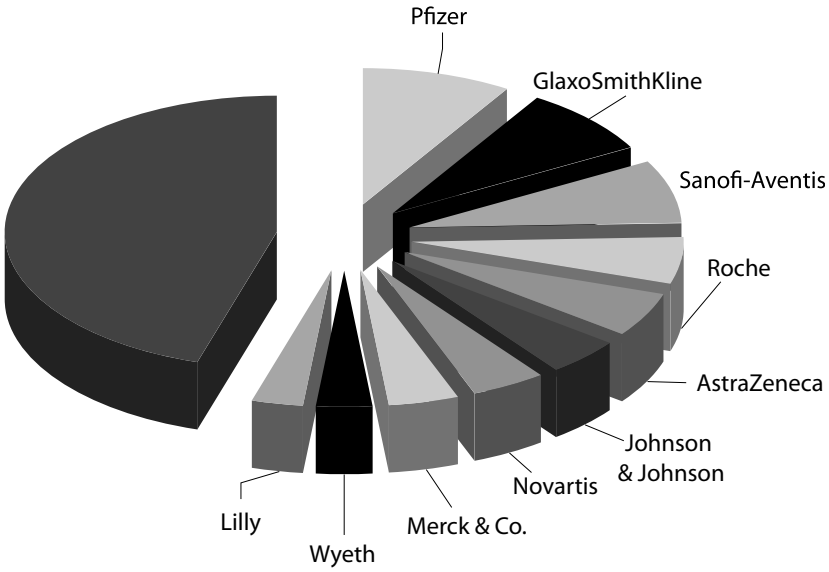
No surprise – workers are taking the biggest hit. In 2007 alone, almost 45,000 pharma jobs were eliminated. Pfizer, the world's biggest pharmaceutical company, rang in the new year by announcing the biggest layoffs – 10,000 people.[1] In the same period – 2007 – salaries of the top suit at the top 10 pharmaceutical companies averaged $13 million.[2] 2008 began with Pfizer announcing another 660 job cuts. Then Wyeth announced 1,200 of its sales reps would be sent packing. Schering-Plough will let go of 10% of its worldwide workforce (that's 5,500 people out of a job). During the first 10 months of 2008, GlaxoSmithKline announced plans to cull over 1,500 workers in the U.S. and UK.

The pharmaceutical industry is ailing, but it's following an aggressive treatment plan. While the prescription includes heavy doses of job cuts, that's not the only profit-booster in Big Pharma's pill bottle:

**If You Can't Beat 'em, Join 'em:** Historically, Big Pharma has taken an arms-length approach to biotech, but a shift was already underway when we published *Oligopoly, Inc. 2005*. In light of the industry-wide drug development drought, Big Pharma is particularly attracted to companies with biotech products (referred to generally as "biologics" because they are derived from living organisms rather than produced via chemistry) nearing regulatory approval. There were 23 pharma/biotech mergers and acquisitions in 2005; 24 deals in 2006; and 19 in 2007, including Schering-Plough's €11 billion purchase of Organon Biosciences and AstraZeneca's $15.6 billion buyout of MedImmune.[3] In April 2008, Japan's Takeda Pharmaceutical bought U. S. biotech firm Millennium for $8.8 billion. In July, Novartis bought a majority stake in biotech Speedel Holding; Eli Lilly bought SGX Pharmaceuticals; Bristol Myer's made a bid to acquire ImClone. In late July, Roche offered to buy the 44% of Genentech it doesn't already own for $43.7 billion.

**If You Can't Beat 'em, Stall 'em:** It's inevitable that even the biggest blockbuster will eventually lose exclusive monopoly patent protection – at least 10 top-selling drugs go off-patent in 2008[4] – despite Big Pharma's demonstrated mastery at staving off the inevitable. The industry is notorious for tweaking drug formulations and winning patents on the "new" drug, taking generic manufacturers to court and/or paying them to delay bringing generic versions to market. Pfizer's attorneys, for example, reached a settlement with India's largest pharmaceutical com-

## Big Pharma: Top 10's Market Share of Top 100 Companies



pany and major generic manufacturer Ranbaxy Laboratories over patents on Lipitor – the world's top-selling drug. As a result, most countries won't see a cheaper version of the cholesterol-lowering drug until more than a *year and a half* after its patent expires in 2010.[5] Pfizer raked in $12.7 billion from Lipitor sales in 2007.[6] Another strategy to cope with monopoly's end is to make deals with generic makers to sell "authorized" generics: Big Pharma licenses a drug formulation to a generic manufacturer who gets rights to use the branded label – it's pure marketing (chemically, the branded generic is the same as a non-branded generic), but the industry will try just about anything to hold on to blockbuster revenues, and the generic maker benefits by charging a higher price. Historically, sales of a proprietary drug drop 80% in the first six months to a year after a generic version becomes available.[7] In an effort to stem revenue losses, Merck made a deal with Watson Pharmaceuticals in January 2008 to produce an authorized generic version of Fosamax, Merck's osteoporosis drug with global sales of $3 billion in 2007[8] and a patent expiration date of February 2008. Other big players are taking a more decisive approach: buying generic companies outright. That's what Japan's Daiichi Sankyo (#22) did in June 2008 when it bought a controlling stake in generic giant Ranbaxy (#64). In the same month Sanofi-Aventis bid $2.6 billion for Czech generic drug maker Zentiva (Sanofi-Aventis already owns a 25% share).

*The four largest vaccine producers control 91.5% of the worldwide vaccine market.*

**If You Can't Cure 'em, Vaccinate 'em:** Vaccines represent one category of biologics getting lots of attention from Big Pharma. With modest annual growth in sales of conventional pharmaceuticals (5%-6 %), industry is shifting focus to the vaccine market, which is growing at 20% per year.[9] The number of vaccines in development tripled from 1996 to 2006.[10] 2007 marked the first year in which revenues from adult vaccines surpassed revenues from pediatric vaccines (good news for business since adults have more disposable cash than kids do).[11] The surge can be attributed largely to Merck's heavily promoted HPV vaccine called Gardasil,[12] which costs between $300 and $500. Influenza vaccines and vaccines against tick-borne encephalitis are also strong sellers. The world vaccine market, estimated at $16.3 billion in 2007, is now controlled by five companies, in order of market share: Merck, GlaxoSmithKline, Sanofi Pasteur (the vaccines division of Sanofi-Aventis), Wyeth, and Novartis.[13] The four largest vaccine producers control 91.5% of the market. Industry analysts predict that the next blockbuster drug will be a new adult vaccine.

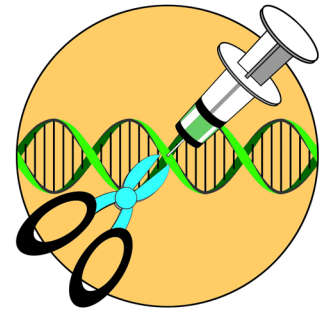
**If You Can't Cure 'em, Sequence 'em:** Big Pharma's growing interest in biotech is related to the rise of genomics and the hype surrounding "personalized medicine" – based on the belief that one day, not too far in the future, it will be possible to detect and treat disease according to an individual's genetic profile. The idea is that variations in our DNA determine our disease-susceptibility or -resilience, as well as how likely we are to benefit from (or be harmed by) a particular drug. With no blockbusters on-deck and recent experience of unexpected losses when golden eggs turn out to be ticking bombs (e.g., Merck's Vioxx was taken off the market in 2004; the development of Pfizer's torcetrapib, the company's best hope for post-Lipitor era profits, was stopped in late 2006 when a clinical trial showed it raised, instead of lowered, the risk

of heart attacks), the industry is ready to try a different approach. Roche (#4) is diving in with a high-profile plan to focus on personalized medicine.[14] Over the course of a few months in 2007, Roche bought five companies related to biologics or gene-based diagnostics, including 454 Life Sciences, a DNA sequencing and analysis company, for $140 million. At the beginning of 2008, Roche bought another diagnostics company, Ventana Medical Systems, for $3.4 billion. One industry analyst describes Roche's strategy this way: "Of course, by eschewing one-size-fits-all drugs in favor of finding meds for smaller, fine-tuned markets, Roche hopes to lower development costs and charge a lot to those very select patients and their insurers."[15]

**If You Can't Develop New Drugs, Find New People to Buy the Old Ones:** China's pharma industry has made headlines recently due to a contaminated blood thinner (heparin, sold by Baxter International [#22]), originating from a Chinese manufacturing plant, which showed up in 11 countries and has been connected to 81 deaths in the U.S.[16] In the long run, however, industry is hoping that *prescriptions* in China rather than *production* in China will have the biggest impact on Big Pharma's bottom line. In June, *The Wall Street Journal* reported on the current "arms race" in China where pharmaceutical companies draw up battle plans and send out legions of sales reps to take control of the country's growing market for prescription drugs – a market expected to reach $46 billion by 2012 (up from $8.4 billion in 2003).[17] AstraZeneca has taken the early lead, increasing its sales force in China five-fold since 2002 and its prescription sales from $85 million in 2001 to $423 million in 2007.[18]

## Biotechnology Industry

### World's Top 10 Publicly-Traded Biotechnology Companies



| Company | 2007 Sales (US$ millions) | % change from 2006 |
|---|---|---|
| 1. Amgen (USA) | 14,771 | 4 |
| 2. Genentech (USA) (Roche acquisition pending) | 9,443 | 24 |
| 3. Monsanto (USA) | 8,563 | 17 |
| 4. Gilead Sciences (USA) | 4,230 | 40 |
| 5. Genzyme (USA) | 3,784 | 19 |
| 6. Biogen Idec (USA) | 3,171 | 18 |
| 7. Applied Biosystems Applera (USA) | 2,089 | 10 |
| 8. PerkinElmer | 1,787 | 16 |
| 9. Cephalon | 1,727 | 0 |
| 10. Biomerieux | 1,645 | 2 |

Source: *Nature Biotechnology,* July 2008

The top 10 publicly-traded biotech companies account for two-thirds of the sector's $78 billion revenues in 2007.

Three of the top 10 biotech companies on our 2005 list didn't make it to 2008, having been snatched up by Big Pharma in a biotech shopping spree: Novartis bought vaccine-maker Chiron for $5.1 billion (2006); Merck bought Serono for $13.9 billion (2007); and AstraZeneca snapped up MedImmune for $15.6 billion (2007). Though Pharma's biotech buys appear be slowing down along with the rest of the economy (e.g., Biogen Idec [#6] put itself up for sale in 2007, but there were no takers), it's clear that the pharmaceutical industry sees biotech as a knight in shining armour – and it's ready to make a long-term commitment. The biggest sign of

pharma's affection for biotech came in late July 2008 when Roche made a bid to buy the 44% of Genentech it doesn't already own for $43.7 billion. Genentech rejected Roche's offer in mid-August, saying it undervalued Genentech; Roche was still "totally committed" to the purchase by late October. Analysts predict that a deal will eventually go through.

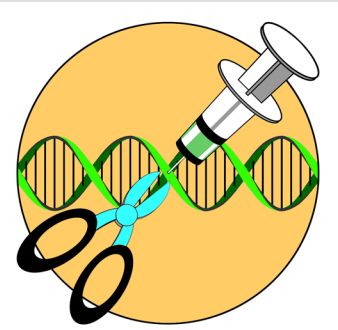
Long-time biotech investors were cheered by the news that after 32 years in the red, publicly-traded companies, taken as a whole, finished out 2007 in the black for the first time – though just barely. The 429 publicly-traded biotech firms tracked by *Nature Biotechnology* managed to eke out $1.1 billion in profit on $78 billion in total revenue, a significant improvement on the sector's losses of $2.6 billion in 2006.[19] But profits were highly concentrated: Only 72 of the 429 companies turned a profit in 2007 – that's just 17% – with by far the greatest profit going to the largest firms.

Five years ago, we reported that the Top 10 public biotech companies accounted for 54% of the sector's total revenue; three years ago, the Top 10 accounted for 72% of total revenues. In 2008, the sector split the difference, with the Top 10 accounting for 66% of $78 billion in total revenues.[20]

*These calculations are derived from Nature Biotechnology's annual survey of the biotech sector, which "purposefully exclude[s]" pharmaceutical companies.[21] That means that when biotech companies are bought by pharmaceutical companies, revenues from their biotech products fall outside the frame of the journal's industry snapshot. For example, when AstraZeneca bought MedImmune in 2007, MedImmune dropped out of sight of Nature Biotech's 2008 survey, as did its revenues. As the pharma and biotech industries become less and less distinct – after all, Roche, the world's fourth largest pharmaceutical company, calls itself the "world's biggest biotech company,"[22] – industry analysts will have to reevaluate how they track the sector's performance. This may be the last time we consider pharma and biotech as separate sectors, though agrochemical giant Monsanto will continue to make things difficult – should we be surprised? – as the only non human health related company in the Top 10.*

The table below shows the Top 10 best-selling biotech drugs in 2007. Of the 10 blockbusters, 4 are made by Amgen; 3 by Genentech and the remaining 3 by pharma giants Johnson & Johnson, Abbot Laboratories and Novartis.

## Biotech's Top 10 Blockbuster Drugs, 2007



| Drug/Company | 2007 Sales (US$ millions) |
|---|---|
| 1. Enbrel / Amgen | 5,275 |
| 2. Remicade / Johnson & Johnson (subsidiary Centocor) | 4,975 |
| 3. Rituxan / Genentech and Biogen Idec partnership | 4,869 |
| 4. Herceptin / Genentech | 4,282 |
| 5. Avastin / Genentech | 3,624 |
| 6. Aranesp / Amgen | 3,614 |
| 7. Humira / Abbot Laboratories | 3,064 |
| 8. Gleevec / Novartis | 3,050 |
| 9. Neulasta / Amgen | 3,000 |
| 10. Procrit / Amgen (marketed by Ortho Biotech) | 2,885 |

Source: *Signals Magazine,* ETC Group

## World's Top 10 Animal Pharma Companies

| Company | 2006 Revenues (US$ millions) |
|---|---|
| 1. Schering-Plough (includes Intervet) (USA) | 2,322 *pro forma* |
| 2. Pfizer (USA) | 2,311 |
| 3. Merial (UK) (joint venture: Merck & Sanofi Aventis) | 2,195 |
| 4. Bayer Animal Health (Germany) | 1,136 |
| 5. Novartis Animal Health (Switzerland) | 940 |
| 6. Fort Dodge Animal Health (USA) | 936 |
| 7. Elanco (USA) | 876 |
| 8. Virbac (USA) | 504 |
| 9. Boehringer Ingelheim (Germany) | 469 |
| 10. Ceva (USA) | 378 |

Source: ETC Group and *Animal Pharm Reports*, September 2007

The worldwide animal health market (which includes veterinary pharmaceuticals, biologicals and medicated feed additives) was valued at $19,160 in 2006. The top 10 companies accounted for 63% of the total market.[23]

In November 2007, Schering-Plough acquired Organon Biosciences for $14,430 million – including its animal pharma subsidiary, Intervet, a vaccine and antiparisitic manufacturer with 2006 sales of $1,412 million. The takeover temporarily made Schering-Plough the biggest animal pharma company – at least on paper.[24] In August 2008, Monsanto announced that it would offload one of its most controversial products – a recombinant bovine growth hormone (rBGH) marketed as Posilac – to Elanco, Eli Lilly's animal health division, for more than $300 million. BGH, or bovine somatotropin (BST), is a hormone designed to increase milk production in dairy cattle. For the past dozen years the product has been plagued by concerns about adverse health effects in cows and people, anti-BGH consumer campaigns, national bans in Japan, Australia, Canada, New Zealand, and most European countries. Wal-Mart's commitment to go rBGH-free may have been the last straw.

The United States represents the largest regional market in the animal health sector – by a factor of five.[25] Though sales in China and Brazil are expected to increase at rates of 8% and 6% per year, respectively, analysts predict the U.S. will remain the largest market (5% annual growth), accounting for almost 37% of worldwide animal health sales estimated to reach $21,700 million in 2010.[26]

A sizeable chunk of animal health sales go to "companion animals" – we used to call them pets (e.g., cats and dogs) – which now receive more medications in the United States than farm animals do.[27] The world's second largest animal pharma firm, Pfizer, makes almost 40% of its revenue from companion animal drug sales. The company sells canine anti-obesity medication (Slentrol) as well as a pill, called Anipryl, to treat cognitive dysfunction syndrome (CDS). Pfizer urges owners of senior dogs to be on the lookout for signs of CDS such as "decreased greeting behavior" and

*Companion animals (e.g., cats and dogs) now receive more medications in the United States than farm animals do.*

cautions: "*Above all, resist the urge to tell yourself that your dog 'is just getting old.'*"[28] (Could Pfizer's antidepressant Zoloft help dog-owners resist the urge?) Novartis markets Chomicalm to treat separation anxiety in dogs; Eli Lilly's version is called Reconcile.

But doting (or daft) dog owners aren't the only contributors to growth in the animal pharma sector. World meat consumption doubled between 1950 and 2005[29] and is expected to double again by 2050, with the global South accounting for the biggest increases.[30] China is now the world's largest meat producer, followed by the United States.[31] Increased meat production means concomitant increases in freshwater shortages, land degradation and greenhouse gas emissions, as well as industrial feedlots that depend on drugs and feed supplements. According to the League of Pastoral Peoples, "three-quarters of the world's chicken, two-thirds of its milk, half of its eggs and one-third of its pigs are produced from industrial breeding lines (i.e. genetically similar animals bred for industrial farming)." [32]

## The BioInformation Industry

Just about every player in the life sciences sector is increasingly dependent on technologies that generate, store, process and analyze information. This includes Big Pharma, Gene Giants and biotech companies, as well as start-ups involved in drug discovery and development, disease diagnostics, personalized and genomic medicine and synthetic biology.
Bioinformatics – using computers to crunch large amounts of biologically-derived data – is the life industry's lynchpin.
Chris Anderson, *Wired's* editor-in-chief, recently claimed that huge amounts of data (on the scale of petabytes – 1000 trillion bytes), combined with computers powerful enough to process the data, signal no less than the end of the scientific method:

> "The scientific method is built around testable hypotheses… The models are then tested, and experiments confirm or falsify theoretical models of how the world works. This is the way science has worked for hundreds of years…But faced with massive data, this approach to science — hypothesize, model, test — is becoming obsolete…We can stop looking for models. We can analyze the data without hypotheses about what it might show. We can throw the numbers into the biggest computing clusters the world has ever seen and let statistical algorithms find patterns where science cannot."[33]

For Anderson, Google provides the best model for advancing the biosciences and J. Craig Venter, data lover *par excellence*, exemplifies the new breed of researchers that need never again ask (or answer) what if or why.

Google may be the archetype, but it was Microsoft that launched the BioIT Alliance in 2006 uniting "the pharmaceutical, biotech, hardware, and software industries to explore new ways to share complex biomedical data and collaborate among multi-disciplinary teams to speed the pace of discovery in the life sciences."[34] The life science industry's data-needs fall roughly into two categories: data generation and data processing. The industry widely uses microarray technology (also called bioarray, DNA chip or gene chip) to generate information from DNA via biological samples – human, plant or microbial cells. Processing, storing and analyzing data requires specialized computer hardware and software.

A microarray is a thin, coin-sized chip. Strands of synthetic DNA are arranged on its surface in a specific order and then a DNA sample (specially prepared in the lab) is placed onto the chip. A scanner equipped with lasers, microscope and camera can "read" the chip and detect how the sample DNA interacted with the chip's synthetic DNA and, from that, generate information about the sample. One microarray can produce thousands and thousands of pieces of data. Making sense of the data is the job of bioinformatics. People working with microarrays wear lab coats: They're handling and preparing biological samples. Bioinformatics folks work with computers and data.

*Bioinformatics is the life industry's lynchpin.*

Personalized medicine, genomics, agbiotech and synthetic biology couldn't exist without the products sold by microarray and scanning technology companies, which are generally specialized and keep a low public profile – companies like Affymetrix, Illumina, Applied Biosystems and Nanogen. Microarray technology is young – less than two decades old – but its long-term dominance as the preferred research tool in the life sciences is uncertain as gene-sequencing technologies, which

**Roche Rushing in All Directions:** The Swiss pharma giant has been on a shopping spree, adding at least five diagnostics and genomics-related companies to its cart since 2007. Already the world's fourth largest pharmaceutical company, Roche made a bid for the world's second largest biotech company (Genentech), plus another big-ticket biotech company in April 2008 (UK's privately-owned Piramed for $175 million). Roche is already a key player in disease diagnostics – its Diagnostics Division hauled in $7.8 billion in 2007.

produce even more data, become less expensive and easier to use. Microarray companies are scrambling to keep their technology relevant by designing a new generation of chips based on more detailed data that have emerged from sequencing technologies. The companies are also diversifying – buying stakes in or merging with sequencing companies (see table below).

Microarray companies tend to serve the life industry through licensing deals and partnerships, though Roche's recent acquisitions of NimbleGen (a microarray company) and 454 Life Sciences (a gene sequencing company) mark a bold move toward controlling the entire "information chain." Companies that provide bioinformatics hardware and software tend to be household names – computing giants in other areas, like Microsoft and IBM.

## Major Players in DNA Data Generation

| Company | 2007 Sales (US$ millions) | What they do, etc. |
|---|---|---|
| 1. Roche Diagnostics Division | 7,800 | In 2007, Roche bought 454 Life Sciences (2006 sales, $18.7 million) for $154.9 million; NimbleGen (2006 sales, $13.5 million sales) for $272.5 million; and BioVeris (FY2006 revenues, $20.6 million) for $600 million. |
| 2. Agilent Technologies | 5,420 | Gene expression microarray technology |
| 3. Invitrogen / Applied Biosystems, Inc. *pro forma* | 3,375 | Invitrogen ($1,282 million, 2007 sales), a DNA sequencing company, will buy ABI, a microarray company ($2,093.5 million, 2007 sales). |
| 4. Beckman Coulter | 2,761 | Manufactures biomedical testing instrument systems, tests and supplies |
| 5. Bio-Rad Laboratories (life science and clinical diagnostics segments only) | 1,447 | Manufactures bioassays, including protein chips and clinical diagnostic kits |
| 6. PerkinElmer (life and analytical science segments only) | 1,327 | Sells microarrays & microarray scanners, genomics analysis software, disease diagnostic kits |
| 7. Affymetrix | 371 | Microarrays, owns ~22% stake in Perlegen Sciences (genome sequencing co.) |
| 8. Illumina | 367 | Genechip maker. Merged with Solexa, a gene sequencing company, early in 2007. Paying $90 million to settle patent infringement suits with Affymetrix |
| 9. MDS Analytical Technologies | 352 | Acquired Molecular Devices Corp. in 2007. Scanners and analysis software for microarrays |
| 10. Caliper Life Sciences | 141 | Sells RNA, DNA and protein expression chips – mainly to pharmaceutical companies for drug discovery |

Sources: ETC Group, company information, *Bio-IT World*

## Major Players in Software, Hardware, DNA Data Processing, Storing and Analyzing


| Drug/Company | FY2007 Revenue (US$ millions) |
|---|---|
| 1. Hewlett-Packard (USA) | 104,286 |
| 2. IBM (USA) | 98,786 |
| (IBM Global Technology Services 2007 revenues = $36,103 million) | |
| 3. Microsoft (USA) | 51,122 |
| 4. Fujitsu Limited (Japan) | 43,249 |
| 5. Apple (USA) | 24,006 |
| 6. Oracle (USA) | 22,430 |
| 7. Google (USA) | 16,594 |
| 8. GE Healthcare (USA) | 16,562 |
| 9. Sun Microsystems (USA) | 13,873 |
| 10. Infosys Technologies (India) | 3,090 |

Source: ETC Group, based on company information

### Notes

1 Andrew Pollack, "Pfizer to Lay Off 10,000 Workers," *The New York Times*, 22 January 2007, www.nytimes.com For stats on other layoffs, see Maureen Martino, "Top 5 layoffs of 2007," www.fiercepharma.com

2 Tracy Staton and Maureen Martino, "Top 17 Paychecks in Big Pharma," 19 May 2008, www.fiercepharma.com Johnson & Johnson's CEO took home $25.1 million; The CEO of Sanofi-Aventis scraped by with $3.27 million.

3 Jennifer Van Brunt, "Much Ado about Biologics," *Signals*, 2 April 2008; http://www.signalsmag.com/signalsmag.nsf/0/B14FA6C0967844478825741E005F1B19

4 Catherine Arnst, "Big Pharma's Patent Headache," *BusinessWeek*, 6 Feb. 2008, www.businessweek.com

5 Stephanie Saul, "Release of Generic Lipitor is Delayed," *New York Times*, 19 June 2008.

6 *Ibid.*

7 Catherine Arnst, "Big Pharma's Patent Headache," *BusinessWeek*, 6 Feb. 2008, www.businessweek.com

8 Anon., "Merck Announces 2007 Financial Results Reflecting Revenue Growth from Key Products," *Business Wire*, 30 Jan. 2008.

9 Kerry Capell, "Vaccines: Back on the Front Burner," *BusinessWeek*, 30 May 2006, www.businessweek.com

10 *Ibid.*

11 Bruce Carlson, "Adults Now Drive Growth of Vaccine Market," *Genetic Engineering & Biotechnology News*, 1 June 2008, http://www.genengnews.com/articles/chitem.aspx?aid=2490.

12 The vaccine targets human papillomavirus (HPV), which in rare cases leads to cervical cancer. Some Merck critics argue that HPV really stands for Help Pay for Vioxx, the $2.5 billion blockbuster anti-inflammatory that was found to cause heart attack and strokes and subsequently taken off the market. In addition, Merck faced 7,000 lawsuits.

13 According to Kalorama Information as reported in Bruce Carlson, "Adults Now Drive Growth of Vaccine Market," *Genetic Engineering & Biotechnology News*, 1 June 2008, http://www.genengnews.com/articles/chitem.aspx?aid=2490. The full report from Kalorama Information costs more than $4,000.

14 Ed Silverman, "Roche's New CEO Talks Up Personalized Medicine," 7 March 2008, Pharma Blog, www.pharmalot.com

15 *Ibid.*

16 Gardiner Harris, "U.S. Identifies Tainted Heparin in 11 Countries," *New York Times*, 22 April 2008.

17 The prediction is from IMS Health and reported in Nicholas Zamiska, "AstraZeneca Looks Beyond Beijing," *The Wall Street Journal*, 13 June 2008; Page B1.

18 Nicholas Zamiska, "AstraZeneca Looks Beyond Beijing," *The Wall Street Journal*, 13 June 2008; Page B1.

19 Stacy Lawrence and Riku Lähteenmäki, "Public biotech 2007 – the numbers," *Nature Biotechnology*, Vol. 26, No. 7, July 2008, pp. 754.

20 *Ibid.*, pp. 753-762.

21 *Ibid.*, p. 753.

22 Jennifer Van Brunt, "Much Ado about Biologics," *Signals*, 2 April 2008; http://www.signalsmag.com/signalsmag.nsf/0/B14FA6C0967844478825741E005F1B19 See also, Roche press release for its self-presentation as "the world's biggest biotech company:" http://www.roche.com/inv-update-2008-01-25

23 Animal Pharm Reports, *Animal Pharm Top 20: 2007 edition*, September 2007, executive summary.

24 Actual 2007 sales put Pfizer back on top with revenue of $2,639 million followed by Merial (almost $2,500 million). In 2007, Schering-Plough came in third with $1,251 million in sales.

25 Animal Pharm Reports, "World Animal Health Markets," September 2006. Executive summary available at http://www.pjbpubs.com/cms.asp?pageid=2467

26 *Ibid.*

27 James Vlahos, "Pill-Popping Pets," *The New York Times*, 13 July 2008.

28 http://www.cdsindogs.com/content_o.asp (emphasis added)

29 Animal Pharm Reports, *Livestock Performance Products & Markets*, Chapter 1, April 2007; available on the Internet: http://www.animalpharmnews.com/magnoliaPublic/ap/reports/2007/chapter1/SR254-livestock-performance-products-markets

30 Steinfeld H. et al., *Livestock's long shadow: environmental issues and options*, Food and Agriculture Organization of the United Nations, 2006. p. iii.

31 Animal Pharm Reports, *Livestock Performance Products & Markets*, Chapter 1, April 2007.

32 Susanne Gura, "Industrial Livestock Production and its Impact on Smallholders in Developing Countries," April 2008, www.pastoralpeoples.org

33 Chris Anderson, "The End of Theory: The Data Deluge Makes the Scientific Method Obsolete," *Wired*, 23 June 2008. On the Internet: http://www.wired.com/science/discoveries/magazine/16-07/pb_theory

34 http://bioitalliance.org/

# Commodifying Nature's Last Straw?

## Extreme Genetic Engineering and the Post-Petroleum Sugar Economy

Peak oil, skyrocketing fuel costs and climate crisis are driving corporate enthusiasm for a "biological engineering revolution" that some predict will dramatically transform industrial production of food, energy, materials, medicine and all of nature. Advocates of converging technologies promise a greener, cleaner post-petroleum future where the production of economically important compounds depends not on fossil fuels – but on biological manufacturing platforms fueled by plant sugars. It may sound sweet and clean, but the so-called "sugar economy" will also be the catalyst for a corporate grab on all plant matter – and destruction of biodiversity on a massive scale.

The future bio-economy will rely on "extreme genetic engineering" – a suite of technologies that are still in early stages of development: cheap and fast gene sequencing; made-to-order biological parts; genome engineering and design; nano-scale materials fabrication and operating systems. The common denominator is that all these technologies – biotech, nanotech, synthetic biology – involve engineering of living organisms at the nano-scale. This technology convergence is driving a convergence of corporate power. New bioengineering technologies are attracting billions of dollars in corporate funding from energy, chemical and agribusiness giants – including DuPont, BP, Shell, Chevron, Cargill – among others.

The 21st century's bio-based future is called the "sugar economy," or the "carbohydrate economy," because industrial production will be based on biological feedstocks (agricultural crops, grasses, forest residues, plant oils, algae, etc.) whose sugars are extracted, fermented and converted into high-value chemicals, polymers or other molecular building blocks. The director of Cargill's industrial bio-products division explains: "With advances in biotechnology, any chemical made from the carbon in oil could be made from the carbon found in plants."[1]

Biological engineering has the potential to affect virtually every sector of the economy that relies on fossil fuels – not only transportation fuels, but also plastics, paints, cosmetics, adhesives, carpets, textiles and thousands more consumer products. Advocates assure us that the "food vs. fuel" debate will be irrelevant in the future sugar economy, because feedstocks will come from

*"Biology can make certain things better than traditional chemistry can."*

*– Charles O. Holliday, Jr., CEO, DuPont*

cheap and plentiful "cellulosic biomass"– plant matter composed of cellulose fibers (including crop residues such as rice straw, corn stalks, wheat straw, wood chips, and dedicated "energy crops" such as switchgrass, fast-growing trees, algae, even municipal waste). The giant stumbling block is that it currently requires a lot of energy to break down some biological feedstocks into sugar, and traditional chemistry has failed to provide an economical process. Proponents insist that "next generation" feedstocks will use old and new biotechnologies, as well as break-through fermentation technologies, to succeed where chemistry failed.

### What is the sugar economy?

Syn Bio enthusiasts envision a post-petroleum era in which industrial production is fueled by sugars extracted from biological feedstocks (biomass). The biotech industry's bioeconomy vision includes a network of biorefineries, where extracted plant sugars are fermented in vats filled with genetically engineered – and one day, fully synthetic – microbes. The microbes function as "living chemical factories," converting sugars into high-value molecules – the building blocks for fuels, energy, plastic, chemicals and more. Theoretically, any product made from petrochemicals could also be made from sugar using this biological manufacturing approach.

**What is biomass?**
Material derived from living or recently living biological organisms. Sources of biomass include all plants and trees, as well as by-products such as organic waste from livestock, food processing and garbage.

## Converging Technologies Crystallize Corporate Power

Eschewing fossil fuels as the planet's economic fulcrum won't happen overnight. It's too soon to tell if sugar-coated visions of the carbohydrate economy are mostly technological hype and hubris, or if bio-based production processes can compete with their petrochemical counterparts. Some of the world's largest corporations are beginning to shift some production away from petrochemicals to bio-based processes. The quest for the sugar economy is fueling high-dollar deals in the university-industry complex, most notably the $500 million alliance between BP and University of California Berkeley.[2] We're also seeing unprecedented corporate alliances involving synthetic biology start-ups and some of the world's largest corporations – including Big Oil, Big Pharma, chemical firms, agribusiness giants, automobile manufacturers, forest product companies and more (see table). For example:

► Agribusiness giant **Archer Daniels Midland Co.** and **Metabolix** formed a joint venture (Telles Co.) to commercialize bioplastics made from corn sugar. The company's biorefinery will produce 110 million pounds of plastic resin per year starting in late 2008.

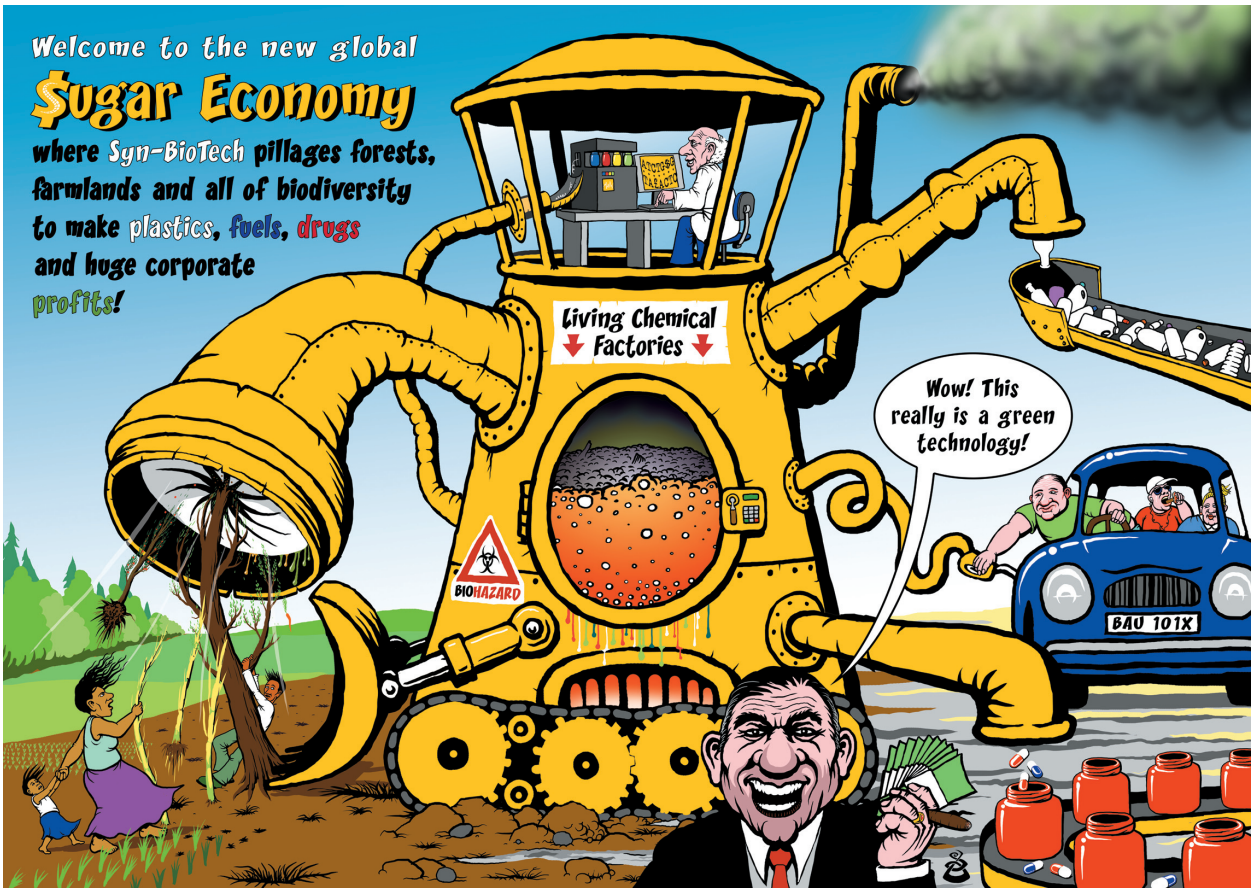
► **DuPont** partnered with sugar giant **Tate & Lyle** (recently sold to agribusiness giant **Bunge**) and **Genencor** to develop a commercial bio-based product – a fiber called "Sorona."

► **BP** is partnering with **Mendel Biotechnologies** to develop genetically engineered perennial grass for fuel.

► **ConocoPhillips** and **Archer Daniels Midland** forged an alliance on cellulosic biofuel production.

► **BP** has a joint venture with **DuPont** to develop biobutanol.

► **Shell** is equity investor in cellulosic ethanol producer **Iogen**.



▶ **General Motors** and **Marathon Oil** are equity investors in **Mascoma**, a company that is engineering microbes to break down biomass and digest sugars.

▶ **Codexis** is developing biocatalytic chemical processes to reduce manufacturing costs of pharmaceuticals, transportation fuels, and industrial chemicals. **Shell**, **Merck**, **Schering-Plough**, **Bristol-Myers Squibb**, and **Pfizer** are among its corporate partners.

▶ **BP** is an equity investor in **Synthetic Genomics**, a synbio company that aims to commercialize synthetic genomic processes for alternative energy.

▶ **Chevron** and **Weyerhaeuser** have a 50-50 joint venture to develop technology for converting cellulose-based biomass into biofuels.

▶ **Chevron** has an agreement with synthetic biology startup **Solazyme** to develop an industrial process to transform algae into diesel fuel.

▶ France's Industrial Innovation Agency is financing a €90 million initiative to develop biomaterials from renewable sources.

▶ The U.S. Department of Energy is investing $385 million in six commercial-scale cellulosic ethanol biorefineries. Corporate partners include: **Cargill**, **Dow**, **DuPont**, **Shell**, **Iogen**, among others.

*"… any chemical made from the carbon in oil could be made from the carbon found in plants."*

– John Stoppert, Cargill

**What is Synthetic Biology?**

Inspired by the convergence of molecular biology, computing and engineering, synthetic biology refers to the creation of designer organisms built from synthetic DNA. Scientists have already used synthetic DNA to construct working viruses and re-engineer existing microbes; they are also attempting to build human-made life forms that perform specific tasks.

Today's industrial bio-economy focuses primarily on agrofuels (biofuels) – especially ethanol and biodiesel. *Nature Biotechnology's* Emily Waltz explains: "The market for fuels swamps that of chemical and material markets, and the prospect of commanding just a piece of it is a draw that many entrepreneurs, governments and investors cannot resist."[3] Since the 1970s, 70% of all U.S. government funding for R&D in biomass has gone to biofuels.[4] In the U.S., energy applications account for 94% of fossil fuel consumption; petrochemicals account for the rest.

Bio-Economic Research Associates (Cambridge, MA) predicts that bio-based chemical processes could capture more than $70 billion in revenues by 2010 – more than 10% of the global chemical industry total. (One analyst predicts that the market for bio-plastics will expand from $1 billion in 2007 to over $10 billion by 2020.[6]) The biofuels sector could reach $40 billion by 2010 and $110-150 billion by 2020. Revenues from vaccines developed with next generation DNA technologies could reach $20 billion by 2010.[7]

## Another Late Lesson from Early Warnings

Recent experience with industrial agrofuels offers a modern day parable about the dangers of techno-fixes that are promoted as green and sustainable solutions to peak oil and climate change. By mid-2008, even some OECD countries were admitting that industrial agrofuels have been a tragic boondoggle that can't be remotely described as a socially or ecologically sustainable response to climate change.[8] Not only are industrial agrofuels driving the world's poorest farmers off their land and into deeper poverty,[9] they are the single greatest factor contributing to soaring food prices[10] and have pushed over 30 million additional people (so far) from subsistence to hunger.[11] Recent scientific papers conclude that industrial agrofuels are not arresting climate change but *accelerating* it.[12]

*"[Synthetic organisms] will replace the petrochemical industry, most food, clean energy and bioremediation."*

*– J. Craig Venter, CEO, Synthetic Genomics, Inc.[13]*

## Synthetic Biology to the Rescue?

But techno-optimists aren't worried – because there are plenty more techno-fixes on the launching pad. Venture capitalists, corporate titans and the U.S. Department of Energy are betting that advances in synthetic biology will overcome the technological bottlenecks that threaten to delay the sugar economy. Synthetic biology, they tell us,

will enable next generation cellulosic feedstocks to be far more efficient and sustainable, and won't compete with land and resources that are used to grow conventional food crops.

Today, synthetic biologists are pursuing a variety of methods to efficiently extract sugars from biomass feedstocks. For example, they are trying to use synthetic microbes to break down cellulosic biomass, and they are also converting microbial cells into "living chemical factories" that manufacture new bio-based products.

Jump-started by U.S. government subsidies,[14] venture capitalists and corporations are supporting R&D (in-house) as well as alliances with synthetic biology start-ups (see table, page 5).

Amyris Biotechnologies, a California-based synthetic biology start-up, aims to engineer new metabolic pathways in microbes so they will produce novel or rare compounds. Although best known for its high-profile efforts to coax engineered cells to produce an anti-malarial compound, the company's primary goal is to modify the genetic pathways of yeast so that it efficiently ferments sugars to produce longer chain molecules of gasoline, diesel and jet fuel. In 2007, Amyris raised $70 million in venture capital to develop synthetic fuel technology.[15] In April 2008 Amyris announced a joint venture with Brazil's Crystalsev to commercialize "advanced renewable fuels" made from sugarcane in 2010 – including diesel, jet fuel and gasoline.[16] In the longer term, Amyris wants to create new production pathways in engineered microbes to churn out pharmaceuticals, flavors, fragrances and nutraceuticals.

*In the name of moving "beyond petroleum" we're seeing a new convergence of corporate power that is poised to appropriate and further commodify biological resources in every part of the globe – while keeping the root causes of climate change intact.*

In September 2008 California-based synthetic biology company, Solazyme, Inc., announced that it has successfully produced the world's first microbial-derived jet fuel by engineering algae to produce oil in fermentation tanks.[17] The company describes it as the first step towards achieving fuel alternatives on a large scale, and claims that its production process can employ a variety of non-food feedstocks, including cellulosic materials such as agricultural residues and high-productivity grasses (bagasse and switchgrass).

DuPont already manufactures a sugar-based biomaterial via engineered microbes.[18] Using a proprietary process developed through partnerships with Genentech and Tate & Lyle, the company engineers the cellular machinery of an *E. coli* bacterium so that it can ferment corn sugar to produce the main ingredient in the company's Sorona fiber, 1,3-propanediol (trademarked name Bio-PDO).[19] Dupont's goal is to one day produce Bio-PDO from cellulosic plant material instead of milled corn. DuPont predicts that Sorona, which can be turned into anything from underwear to carpeting, will eventually replace nylon. Although Sorona fiber is neither compostable nor biodegradable, DuPont boasts that it's environmentally friendly because its production requires 40 percent less energy and reduces greenhouse gas emissions by 20 percent compared to petroleum-based propanediol. But it takes six million bushels of corn to produce 100 million pounds of Bio-PDO – the estimated annual output of DuPont's Tennessee-based (USA) bio-refinery.[20] And that's just one example of one biorefinery producing just one bio-based material for a single year. In other words, synthetic biology's state-of-the-art, sugar-dependent biorefineries will create a massive demand for agricultural feedstocks. According to biotech industry estimates, a minimum of 500,000 acres of cropland (that is, the crop residues or "wastes" from that area) would be required to sustain a moderately-sized, commercial-scale biorefinery.[21]

Synthetic biology's grand vision of a post-petroleum era depends on biomass – whether derived from "energy crops," trees (including GE trees), agricultural "wastes," crop residues or algae. If the vision of a sugar economy advances, will *all* plant matter become a potential feedstock? Who decides what qualifies as agricultural waste or residue? *Whose* land will grow the feedstocks? An article in the February

### Breaking the Biomass Bank: Limits to (plant) Growth

"Almost all of the arable land on Earth would need to be covered with the fastest-growing known energy crops, such as switchgrass, to produce the amount of energy currently consumed from fossil fuels annually." – U.S. Department of Energy, 2005[25]

The earth's plant biomass is rapidly dwindling. Forests and grasslands, in particular, are disappearing at an alarming rate. Researchers estimate that humans already consume almost a quarter of global biomass (24%). Of that amount, more than half (53%) is harvested for food, fuel, heating and lumber. 40% is lost through land use changes and 7% is burned in human induced fires.[26]

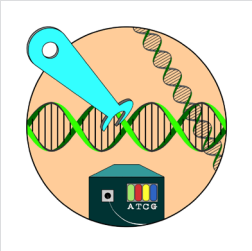
The United States currently consumes 190 million dry tonnes of biomass annually for energy, and the government wants to increase that figure to one billion tonnes. Researchers conclude that the goal is technically feasible, but only by increasing yields of energy crops by 50% and by removing large quantities (~75%) of agricultural residues from cropland. Impacts of increased residue removal will include impoverished soils (requiring more industrial fertilizers) and dangerous increases in soil erosion.[27]

2008 issue of *Nature* suggests that synthetic biology approaches "might be tailored to marginal lands where the soil wouldn't support food crops." (emphasis added)[22] The implications, especially for marginalized farming communities and poor people in the South, are profound. At a May 2006 meeting of synthetic biologists, Nobel laureate Dr. Steven Chu pointed out that there is "quite a bit" of arable land suitable for rain-fed energy crops, and that Latin America and Sub-Saharan Africa are areas best suited for biomass generation. Failing to learn from the first-generation agrofuel train wreck, *The Economist* naively suggests that "there's plenty of biomass to go around" and that "the world's hitherto impoverished tropics may find themselves in the middle of an unexpected and welcome industrial revolution."[23]

Advocates of synthetic biology and the bio-based sugar economy assume that unlimited supplies of cellulosic biomass will be available. But can massive quantities of biomass be harvested sustainably without eroding/degrading soils, destroying biodiversity, increasing food insecurity and displacing marginalized peoples? Can synthetic microbes work predictably? Can they be safely contained and controlled? No one knows the answers to these questions, but that's not curbing corporate enthusiasm. In the current social and economic context, the global grab for next generation cellulosic feedstocks threatens to repeat the mistakes of first-generation agrofuels on a more massive scale.

The pattern is familiar. Once again, land, labour and biological resources in the global South are in danger of being exploited to satisfy the North's voracious consumption and reckless waste. In the name of moving "beyond petroleum" we're seeing a new convergence of corporate power that is poised to appropriate and further commodify biological resources in every part of the globe – while keeping the root causes of climate change intact.[24]

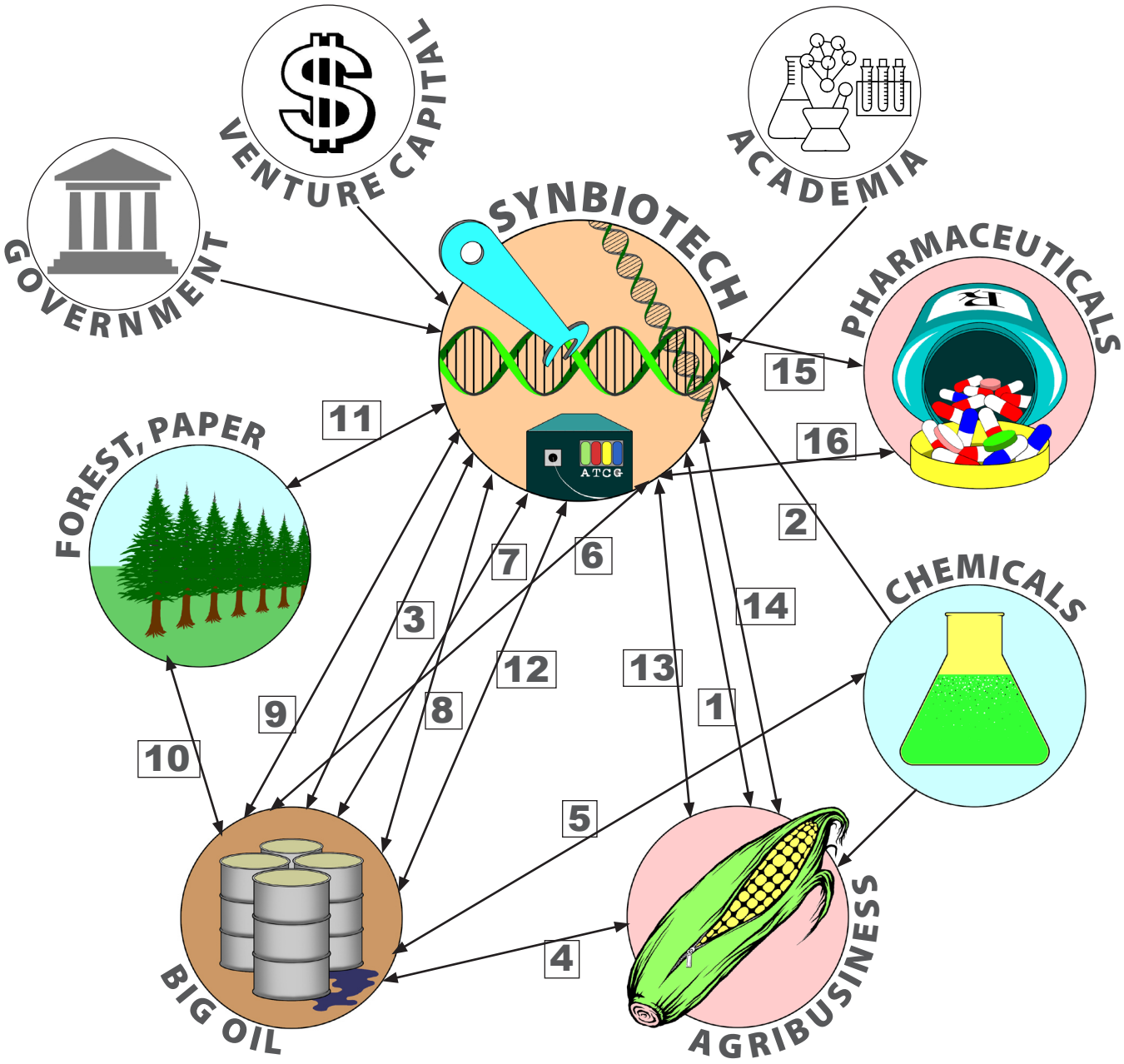
An upcoming report by ETC Group and the Global Justice Ecology Project will examine the far-reaching implications of the sugar economy, especially for marginalized communities in the global South.




# Synthetic Biology Players and Corporate Partners

| COMPANY | CORPORATE PARTNERS/INVESTORS | COMPANY FOCUS |
|---|---|---|
| **Amyris Biotechnology** Emeryville, CA, USA | Partnership with CrystalSev (one of Brazil's largest sugar and ethanol manufacturer); Sanofi-Aventis; Khosla Ventures; Kleiner Perkins Caufield & Byers; TPG Ventures (TPGV); Amyris CEO is John Melo, previously president of U.S. Fuels Operations for BP | Using synthetic biology to commercialize biofuels, pharmaceuticals, fine chemicals, and nutraceuticals. |
| **Athenix** Research Triangle Park, NC, USA | Syngenta; Monsanto; Iowa Corn Promotion Board | Developing genes and enzymes to enable processes to release sugars from biological feedstocks. |
| **Codexis** Redwood City, CA, USA | Shell; Merck; Schering-Plough; Bristol-Myers Squibb; Pfizer; Chevron; Maxygen; Pequot Ventures; CMEA Ventures; Bio*One Capital | Developing biocatalytic chemical processes to reduce manufacturing costs of pharmaceuticals, transportation fuels, and industrial chemicals. |
| **Coskata** Warrenville, IL, USA | General Motors; ICM | Biology-based renewable energy company. Using proprietary microorganisms and bioreactor designs, aims to produce ethanol for under US$1.00 per gallon. |
| **Genencor (Danisco subsidiary)** Rochester, NY, USA | Goodyear Tire & Rubber; DuPont; Procter & Gamble; Cargill; Dow; Eastman Chemical | Engineering protein (enzyme) products for industrial applications (i.e., grain processing, cleaning, textiles, biofuels). |
| **Genomatica** San Diego, CA, USA | Iceland Genomic Ventures; Mohr Davidow Ventures (MDV); Alloy Ventures; Draper Fisher Jurvetson | Engineering microorganisms to make an industrial chemical used in plastic, rubber and fiber products. |
| **Gevo** Englewood, CO, USA | Virgin Group; Khosla Ventures; Burrill & Company; Malaysian Life Sciences Capital Fund | Developing large-scale production of advanced biofuels, including butanol (higher-energy biofuel than ethanol). |
| **LS9** S. San Francisco, CA, USA | Diversa; Khosla Ventures; Flagship Ventures; Lightspeed Ventures Partners | Using synthetic biology to develop petroleum and other oil-based industrial products. |
| **Mascoma** Boston, MA, USA | General Motors and Marathon Oil are equity investors; Khosla Ventures; Kleiner Perkins Caufield & Byers; Pinnacle Ventures; Vantage Point Venture Partners, U.S. Dept. of Energy | Employing engineered microbes to break down biomass and digest sugars. |
| **Metabolix** Cambridge, MA, USA | Archer Daniels Midland; U.S. Department of Energy | Developing proprietary platform technology for co-producing plastics, chemicals and energy from switchgrass, oilseeds and sugarcane. |
| **Novozymes (Novo Nordisk Foundation)** Bagsvaerd, Denmark | Center for Sustainable and Green Chemistry and Dept. of Chemical Engineering at The Technical University of Denmark (DTU); Danish National Advanced Technology Foundation; Department of Energy's National Renewable Energy Laboratory (NREL) | Engineering enzyme genes using a technique called artificial evolution for industrial applications. |
| **Solazyme** S. San Francisco, CA, USA | Chevron; Imperium Renewables, Inc.,;Blue Crest Capital Finance, L.P. | Engineering marine microbes to create renewable energy, industrial chemicals. |
| **Synthetic Genomics** La Jolla, CA, USA | BP; Asiatic Centre for Genome Technology (ACGT, Malaysia) subsidiary of the Genting Group; Biotechonomy LLC; Draper Fisher Jurvetson; Desarrollo Consolidado de Negocios; Meteor Group LLC | Using synthetic genomic processes and naturally occurring processes for alternative energy. |
| **Verenium** Cambridge, MA, USA | Marubeni Corp.;Tsukishima Kikai Co.; BASF; DuPont; Danisco; Cargill; Bunge; Syngenta | Created by 2007 merger of Diversa & Celunol. Developing cellulosic ethanol. |

## The New Biomas(s)ters: Crystallizing Corporate Power




### Sample Alliances

1. ADM + Metabolix
2. DuPont + Tate & Lyle + Genencor
3. BP + Mendel Biotechnologies
4. ADM + ConocoPhillips
5. BP + DuPont
6. General Motors + Marathon Oil + Mascoma
7. Shell + Codexis
8. BP + Synthetic Genomics
9. Chevron + Solazyme
10. Chevron + Weyerhaeuser
11. International Paper / MeadWestvaco / Rubicon Limited + Arborgen
12. Royal Dutch Shell + Codexis
13. Royal Nedalco + Mascoma
14. Crystalsev + Amyris
15. Pfizer + Codexis
16. Merck & Co. + Codexis

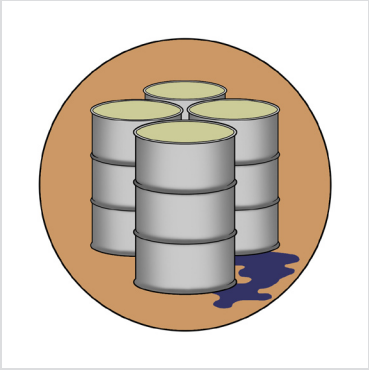
## Leading Commercial Gene Synthesis Companies


| Company |
|---|
| GeneArt (Germany) |
| Blue Heron Biotech (USA) |
| DNA 2.0 (USA) |
| GenScript (USA) |
| Integrated DNA Technologies (USA) |
| Bio S&T (Canada) |
| Epoch Biolabs (USA) |
| Bio Basic, Inc. (Canada) |
| BaseClear (Netherlands) |

Source: ETC Group

Note: Synthetic DNA is the raw material for creating artificial life. Our list includes the leading companies involved in commercial gene synthesis (companies that specialize in synthesizing long pieces of double-stranded DNA). Only one, GeneArt, is publicly traded.

## Petroleum Refining: Top 10

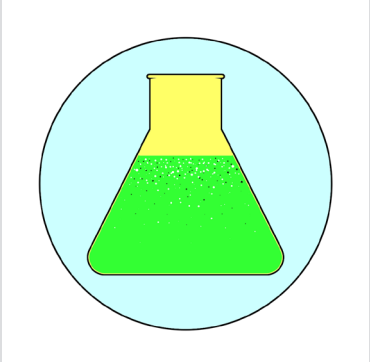


| Company | 2007 Revenues (US$ millions) |
|---|---|
| 1. ExxonMobil (USA) | 372,824 |
| 2. Royal Dutch Shell (Netherlands) | 355,782 |
| 3. BP (UK) | 291,438 |
| 4. Chevron (USA) | 210,783 |
| 5. Total (France) | 187,280 |
| 6. ConocoPhillips (USA) | 178,558 |
| 7. China Petroleum & Chemical (China) | 159,260 |
| 8. China National Petroleum (China) | 129,798 |
| 9. ENI (Italy) | 120,565 |
| 10. Valero Energy (USA) | 96,758 |

Source: CNN/Global Fortune 500 2008

The world's 39 largest petroleum refiners had combined revenues of $3.3 trillion in 2007. The top 10 petroleum companies account for 64% of the revenues earned by the 39 largest refiners.

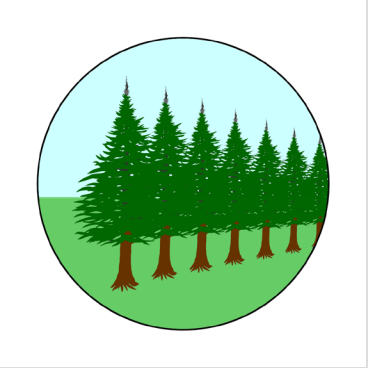
## Chemical Industry: Top 10



| Company | 2007 Chemical Revenues (US$ millions) |
|---|---|
| 1. BASF (Germany) | 65,037 |
| 2. Dow Chemical (USA) | 53,513 |
| 3. Shell (UK) | 45,911 |
| 4. Ineos Group (UK) | 37,686 |
| 5. ExxonMobil (USA) | 36,826 |
| 6. China Petroleum & Chemical (China) | 30,676 |
| 7. SABIC (Saudi Arabia) | 29,276 |
| 8. DuPont (USA) | 29,218 |
| 9. Total (France) | 28,786 |
| 10. Formosa Plastics Group (Taiwan) | 26,541 |

Source: *Chemical & Engineering News*, 28 July 2008 .

## Forest, Paper & Packaging Corporations: Top 10



| Company | 2007 Revenues (US$ millions) |
|---|---|
| 1. International Paper (USA) | 21,890 |
| 2. Stora Enso (Finland) | 18,322 |
| 3. Kimberly-Clark (USA) | 18,266 |
| 4. Svenska Cellulosa (Sweden) | 15,675 |
| 5. Weyerhaeuser (USA) | 13,949 |
| 6. UPM (Finland) | 13,748 |
| 7. Oji Paper (Japan) | 10,758 |
| 8. Metsaliitto (Finland) | 10,507 |
| 9. Nippon Unipac (Japan) | 9,990 |
| 10. Smurfit Kappa (Ireland) | 9,963 |

Source: PricewaterhouseCoopers, 2008

Sales of the top 100 forestry and paper companies totaled US $343,300 million in 2007.[30] The 10 largest companies account for 42% of total sales. The 20 largest account for nearly 60% of total sales.

## Companies involved in Oilseed, Grain and Sugar Processing/Trading: Top 11

| Company | FY2007 Revenues (US$ millions) |
|---|---|
| 1. Cargill (USA) | 88,300 |
| 2. Bunge Ltd. (Bermuda) | 44,804 |
| 3. Archer Daniels Midland (USA) | 44,018 |
| 4. Marubeni (Japan) (includes Columbia Grain International) | 36,481 |
| 5. The Noble Group (UK) | 23,497 |
| 6. Itochu Intl. (Japan) | 22,424 |
| 7. China National Cereals, Oils & Foodstuffs (China) | 21,202 |
| 8. Louis Dreyfus Commodities (France) | >20,000[28] |
| 9. Wilmar International Ltd. (Singapore) | 16,466 |
| 10. Associated British Foods (UK) | 13,355 (3,610 sugar)[29] |
| 11. ConAgra Foods (USA) | 12,755 |

Sources: ETC Group, GRAIN, company information, CNN/Global Fortune 500 2008

## Notes

1 Bio-era, "Genome Synthesis and Design Futures: Implications for the U.S. Economy," A Special Bio-era Report Sponsored by the U.S. Department of Energy, February 2007, p. 89.

2 For extensive examples of university-industry alliances, see: ETC Group, "Peak Soil + Peak Oil = Peak Spoils," *Communiqué*, November/December 2007. http://www.etcgroup.org/en/materials/publications.html?pub_id=668

3 Emily Waltz, "Do biomaterials really mean business," *Nature Biotechnology*, Vol. 26, Number 8, August 2008.

4 Emily Waltz, "Do biomaterials really mean business," *Nature Biotechnology*, Vol. 26, Number 8, August 2008.

6 http://www.hkc22.com/bioplastics.html

7 Bio-era, "Genome Synthesis and Design Futures: Implications for the U.S. Economy," A Special Bio-era Report Sponsored by the U.S. Department of Energy, February 2007

8 The title of one OECD working paper on biofuels said it all: "Is the cure worse than the disease?"

9 http://esa.un.org/un-energy/pdf/susdev.Biofuels.FAO.pdf

10 According to leaked World Bank document (April 2008). http://image.guardian.co.uk/sys-files/Environment/documents/2008/07/10/Biofuels.PDF

11 A June 2008 report from Oxfam claims that biofuel policies in OECD countries have already plunged more than 30 million additional people into poverty. Source: http://www.oxfam.org.uk/resources/policy/climate_change/bp114_inconvenient_truth.html

12 When total carbon costs of biofuel production are taken into account, all the major agrofuels increase greenhouse gas (GHG) emissions. (Corn-based ethanol nearly doubles GHG emissions over 30 years and increases GHG for 167 years).Timothy Searchinger, *et al.* "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change," *Science* 319, 1238 (2008).

13 http://www.newsweek.com/id/34406

14 By 2022, U.S. energy policy dictates that 44% of U.S. production of biofuels must come from cellulosic feedstocks.

15 Amyris News Release, "Amyris Biotechnologies Announces $70 Million Series B Round," September 19, 2007. http://www.amyrisbiotech.com

16 Amyris News Release, "Amyris and Crystalsev Join to Launch Innovative Renewable Diesel from Sugarcane by 2010," April 23, 2008. http://www.amyrisbiotech.com

17 Solazyme, Inc., News Release, "Solazyme Produces World's First Algal-Based Jet Fuel - Fuel Passes All Tested Specifications including the Most Critical ASTM D1655 Specifications, September 9, 2008." http://www.solazyme.com/news090908.shtml

18 According to DuPont, Sorona contains "37% renewably sourced material (by weight) derived from corn." Sorona is neither compostable nor biodegradable. See: http://www2.dupont.com/Renewably_Sourced_Materials/en_US/sorona.html

19 Dave Nilles, "Tate & Lyle and DuPont ship propanediol from Tennessee plant," *Ethanol Producer Magazine*, November 2006. On the Internet: http://www.ethanolproducer.com/article.jsp?article_id=2488

20 Peg Zenk, "Biotech's Third Wave," *Farm Industry News*, 1 February 2007.

21 Biotechnology Industry Organization, "Achieving Sustainable Production of Agricultural Biomass for Biorefinery Feedstock," on the Internet: www.bio.org/ind/biofuel/SustainableBiomass-Report.pdf

22 "Not your father's biofuels," *Nature*, Vol. 451, 21 Feb. 2008.

23 Anonymous, "Grow Your Own," *Economist*, June 19, 2009.

24 ETC Group, "Peak Soil + Peak Oil = Peak Spoils," *Communiqué*, November/December 2007. http://www.etcgroup.org/en/materials/publications.html?pub_id=668

25 U. S. Department of Energy, "Basic Research Needs for Solar Energy Utilization: Report on the Basic Energy Sciences Workshop on Solar Energy Utilization," 2005.

http://www.sc.doe.gov/bes/reports/files/SEU_rpt.pdf

26 Helmut Haberl *et al.*, "Quantifying and mapping the human appropriation of net primary production in earth's terrestrial ecosystems," *Proceedings of the National Academy of Sciences*, vol. 104, no. 31, July 31, 2007 http://www.pnas.org/content/104/31/12942

27 US Department of Energy and US department of Agriculture, *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: the Technical Feasibility of a Billion-Ton Annual Supply*, April 2005. http://www1.eere.energy.gov/biomass/pdfs/final_billionton_vision_report2.pdf

28 Louis Dreyfus Commodities is part of Louis Dreyfus Group, a privately-held company headquartered in France. According to its website: "Aggregate average annual gross sales in recent years have exceeded $20 billion." LD-Commodities is "consistently ranked among the largest merchandisers of grains…[and] oilseeds…ranks as one of the top three sugar merchants and traders in the world, handling both raw and white sugar and handling more than 2.5 million tons of sugar annually. The company owns three Brazilian sugar mills that produce 450,000 tons of sugar and 150,000 cubic meters of alcohol annually." http://www.ldcommodities.com/index.php?id=1410

29 ABF's fiscal year ends 15 September. September 2007 ABF reported global sales of GBP 6,800 million (US$13,355.2) and GBP 1,838 million (US$3,610 million) from its sugar and agriculture business. Average exchange rate from 16 Sept. 2006-15 Sept. 2007: 1 GBP = US$1.96400 www.oanda.com

30 PricewaterhouseCoopers, *Global Forest, Paper & Packaging Industry Survey*, 2008 edition, p. 7.

# Conclusion

Challenges to corporate hegemony as well as strategies for social control of technology are being led by peasant farmers, social movements and civil society at all levels in every region of the world. And support in challenging the *status quo* is emerging in unlikely places.

The first-ever independent global assessment of agricultural science and technology, approved by 58 governments in April 2008, warns that the world can't rely on technological fixes – such as transgenic crops – to solve systemic problems of persistent poverty, hunger and environmental crises. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), sponsored by the World Bank, the Food and Agriculture Organization and other U.N. agencies – with participation from civil society throughout the 3-year process – recognizes the undue influence of transnational agribusiness on trade and agricultural policies that have destroyed and disadvantaged farming communities around the world. According to Marcia Ishii-Eiteman, senior scientist at Pesticide Action Network North America, and one of the lead authors of the IAASTD global report, "[the assessment] acknowledges that small-scale, low-impact farming contributes crucial ecological and social functions that must be protected, and that nations and peoples have the right to democratically determine their own food and agricultural policies."[1]

The IAASTD Report should be an important reference for continued debate and action in the intergovernmental arena on issues related to agricultural development and technology. The participation of peasants, small farmers, fisherfolk, pastoralists and indigenous peoples is crucial. At the national level, ETC Group recommends that every country undertake a "Peoples' Food Commission" involving peasants and marginalized peoples that will investigate the food crisis, hold hearings and report on how to implement a national plan for food sovereignty.

*Decisions made in the next few years regarding powerful new technologies have the potential to affect jobs, justice and the environment on a planetary scale. Despite the implications for democracy and human rights, no international body exists to monitor global corporate activity, and no U.N. body has the capacity to monitor and evaluate global technologies.*

## A Tale of Two Realities

| The Corporate Economy | The Local Economy |
|---|---|
| The top 10 seed companies control 67% of the global proprietary seed market and 82% of the world's commercial seed sales are proprietary. | Three-quarters of the world's farmers either grow locally-bred varieties and/or save their seed. At least 1.4 billion people depend upon farmer-saved seed. |
| 80% of agribusiness research is devoted to shipping, storage and market-maximization technologies. | 100% of farmer-based research is devoted to environmental sustainability, productivity and nutrition. |
| The top 100 grocery retail enterprises account for 35% of global grocery retail sales. | 85% of global food production is consumed close to where it is grown – much of it outside the formal market system. |
| The top 10 pharmaceutical companies control 55% of global drug sales. | Approximately 70% of the world's population is cared for by community health specialists using local medicines. |

**Vacuum in Global Governance:** In 2005 the United Nations Conference on Trade and Development (UNCTAD) issued a report on corporate concentration that cites the need to improve world governance on questions of corporate conduct and competition. Unfortunately, UNCTAD's report concludes with the strikingly impotent observation that "no international competition standards exist to effectively regulate corporate activity from one continent to another."[2]

Today, corporations are the dominant power shaping social, economic and trade policy worldwide. At the same time, decisions made in the next few years regarding powerful new technologies have the potential to affect jobs, justice and the environment on a planetary scale. Despite the implications of these trends for democracy and human rights, no international body exists to monitor global corporate activity, and no U.N. body has the capacity to monitor and evaluate global technologies. The current food emergency and imploding global economy testify to the glaring need for monitoring and oversight of corporations.

**Addressing Synthetic Biology's Sugar Economy and Technology Convergence:** In recent years, multilateral institutions involved in food, agriculture and biodiversity have been forced to examine the disastrous socio-economic, environmental and human rights implications of industrial agrofuels. Instead of calling for a moratorium and dismantling targets and subsidies, many governments are ducking for cover and calling for "next generation" liquid biofuels that will purportedly rely on non-edible cellulosic biomass – all of it made possible by future advances in biotechnology that may or may not come to pass.

In late 2008, for example, FAO will host a forum to examine the role of agricultural biotechnologies for second generation production of bioenergy in the South. This approach is dangerously short-sighted. With the specter of biorefineries fueled by plant-derived sugars, corporations are gearing up to capture and commodify plant biomass. The

goal is not just bioenergy, but industrial-scale production of chemicals, plastics, drugs, textiles, flavors, fragrances and more. The issue must be expanded beyond biotech to include synthetic biology and technology convergence. The FAO and CBD must urgently examine the implications of extreme genetic engineering for biodiversity, agriculture and the livelihoods of farming communities worldwide.

ETC Group and other civil society organizations have put forth proposals for establishing an intergovernmental framework that would allow the monitoring and evaluation of new technologies as they evolve from initial scientific discovery through to possible commercialization (International Convention on the Evaluation of New Technologies -ICENT). A transparent and participatory process for early warning/early listening to monitor significant new technologies is needed now more than ever.

Among other regional and international meetings devoted to social control of technology, ETC Group and civil society partners will convene in late November in Montpellier, France to discuss long-term strategic planning on global technopolies. Discussions will continue on a larger scale at the 2009 World Social Forum in Belém, Brazil (January 2009) during special sessions on science, society and democracy.

## Notes

1 Marcia Ishii-Eiteman, "New Era for Agriculture?" *Food First Backgrounder*, Summer 2008.

2 UNCTAD, "Tracking the Trend Towards Market Concentration: The Case of the Agricultural Input Industry," Prepared by the UNCTAD Secretariat, UNCTAD/DITC/COM/2005/16, 2005.

**Reforming the Multilateral Food System:**

In 2008 ETC Group published a series of reports on the governance crisis afflicting the world's major multilateral food and agriculture institutions:

*Communiqué* No. 97: *"Food's Failed Estates = Paris's Hot Cuisine, Food Sovereignty – à la Cartel?"* January 2008

Translator: *"Ciao FAO: Another 'Failure-as-Usual' Food Summit,"* June 2008

In the absence of decisive intergovernmental action, and in hopes of stimulating further debate, ETC Group's forthcoming *Communiqué* No. 101, offers specific proposals for reforming the multilateral food system. *Low-Visionaries at High-Level Fora Overlook Governance – Multilateral System's Failed Estates Exacerbate Food Crisis* will be available at www.etcgroup.org

# The Global Economy: Who's Got the Power?

*Corporate Revenue vs. National Income*

**GNI is Gross National Income*

| | Company or Country | GNI* 2007 (countries) or 2007 Revenue (Companies) US$millions |
|---|---|---|
| 1 | United States | 13,886,472 |
| 2 | Japan | 4,813,341 |
| *Net Worth of the World's Wealthiest 1,125 people* | | *~4,400,000* |
| 3 | Germany | 3,197,029 |
| 4 | China | 3,120,891 |
| 5 | United Kingdom | 2,608,513 |
| 6 | France | 2,447,090 |
| 7 | Italy | 1,991,284 |
| 8 | Spain | 1,321,756 |
| 9 | Canada | 1,300,025 |
| 10 | Brazil | 1,133,030 |
| 11 | Russian Federation | 1,070,999 |
| 12 | India | 1,069,427 |
| 13 | Korea, Rep. | 955,802 |
| 14 | Mexico | 878,020 |
| 15 | Australia | 755,795 |
| 16 | Netherlands | 750,526 |
| 17 | Turkey | 592,850 |
| 18 | Switzerland | 452,121 |
| 19 | Belgium | 432,540 |
| 20 | Sweden | 421,342 |
| 21 | Poland | 374,633 |
| 22 | Saudi Arabia | 373,490 |
| 23 | Indonesia | 373,125 |
| 24 | Norway | 360,036 |
| 25 | Austria | 355,088 |
| 26 | Wal-Mart | 351,139 |
| 27 | ExxonMobil | 347,254 |
| 28 | Greece | 331,658 |
| 29 | Royal Dutch Shell | 318,845 |
| 30 | Denmark | 299,804 |
| 31 | BP | 274,316 |
| 32 | South Africa | 274,009 |
| 33 | Iran, Islamic Rep. | 246,544 |

| | Company or Country | GNI* 2007 (countries) or 2007 Revenue (Companies) US$millions |
|---|---|---|
| 34 | Argentina | 238,853 |
| 35 | Finland | 234,833 |
| 36 | Hong Kong, China | 218,910 |
| 37 | Thailand | 217,348 |
| 38 | Ireland | 210,168 |
| 39 | General Motors | 207,349 |
| 40 | Toyota Motors | 204,746 |
| 41 | Venezuela, RB | 201,146 |
| 42 | Portugal | 201,079 |
| 43 | Chevron | 200,567 |
| 44 | Daimler Chrysler | 190,191 |
| 45 | Malaysia | 173,705 |
| 46 | ConocoPhillips | 172,451 |
| 47 | Total | 168,357 |
| 48 | General Electric | 168,307 |
| 49 | Ford Motor | 160,126 |
| 50 | ING Group | 158,274 |
| 51 | Israel | 157,065 |
| 52 | Colombia | 149,934 |
| 53 | Czech Republic | 149,378 |
| 54 | Singapore | 148,992 |
| 55 | Citigroup | 146,777 |
| 56 | Philippines | 142,623 |
| 57 | Pakistan | 141,009 |
| 58 | AXA | 139,738 |
| 59 | Chile | 138,630 |
| 60 | Nigeria | 137,091 |
| 61 | Romania | 132,502 |
| 62 | Volkswagen | 132,323 |
| 63 | Sinopec | 131,636 |
| 64 | Algeria | 122,465 |
| 65 | Crédit Agricole | 128,481 |
| 66 | Allianz | 125,346 |
| 67 | New Zealand | 121,708 |

| | Company or Country | GNI* 2007 (countries) or 200 Revenue (Companies) US$millions |
|---|---|---|
| 68 | Fortis | 121,202 |
| 69 | Egypt, Arab Republic | 119,405 |
| 70 | Ukraine | 118,445 |
| 71 | Bank of America | 117,017 |
| 72 | Hungary | 116,303 |
| 73 | HSBC Holdings | 115,361 |
| 74 | American Int'l Group | 113,194 |
| 75 | China National Petroleum | 110,520 |
| 76 | BNP Paribas | 109,214 |
| 77 | ENI | 109,014 |
| 78 | UBS | 107,834 |
| 79 | Siemens | 107,342 |
| 80 | State Grid | 107,186 |
| 81 | Assicurazioni Generali | 101,811 |
| 82 | J.P. Morgan Chase & Co. | 99,973 |
| 83 | Carrefour | 99,015 |
| 84 | Berkshire Hathaway | 98,539 |
| 85 | Pemex | 97,469 |
| 86 | Peru | 96,241 |
| 87 | Deutsche Bank | 96,152 |
| 88 | Dexia Group | 95,847 |
| 89 | Honda Motor | 94,791 |
| 90 | McKesson | 93,574 |
| 91 | Verizon | 93,221 |
| 92 | Nippon | 91,998 |
| 93 | Hewlett-Packard | 91,658 |
| 94 | IBM | 91,424 |
| 95 | Valero Energy | 91,051 |
| 96 | Home Depot | 90,837 |
| 97 | Nissan Motor | 89,502 |
| 98 | Samsung Electric | 89,476 |
| 99 | Credit Suisse | 89,354 |
| 100 | Hitachi | 87,615 |

Sources: World Bank (World Development Indicators database, 1 July 2008), *Fortune* Global 500, 2008

ETC Group is an international civil society organization based in Canada. We are dedicated to the conservation and sustainable advancement of cultural and ecological diversity and human rights. ETC group supports socially responsible developments of technologies useful to the poor and marginalized and we address international governance issues affecting the international community. We also monitor the ownership and control of technologies and the consolidation of corporate power.

**www.etcgroup.org**

ETC Group publications are available free-of-charge on ETC Group's website.