Who will control the Green Economy?

As governments prepare to sanction a Green Economy at Rio+20, ETC Group provides an update on corporate power and warns that the quest to control biomass will perpetuate the Greed Economy.

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"We are told by men of science
that all the venture of mariners on the sea,
all that counter-marching tribes and races that
confounds old history with its dust and rumour,
sprang from nothing more abstruse than
the laws of supply and demand, and a
certain natural instinct for cheap rations.
To any one thinking deeply, this
will seem a dull and pitiful
explanation."
—Robert Louis Stevenson,
Will o' the Mill, 1901

"As long as the maximization of profit
remains the cornerstone of acquisitive society
and capitalist economy, corporations will
retain their interest in scarcity as a
creator of economic value."
—German-born economist, Erich W. Zimmermann,
in *World resources and industries: a functional appraisal of the availability of agricultural and industrial materials,* 1933

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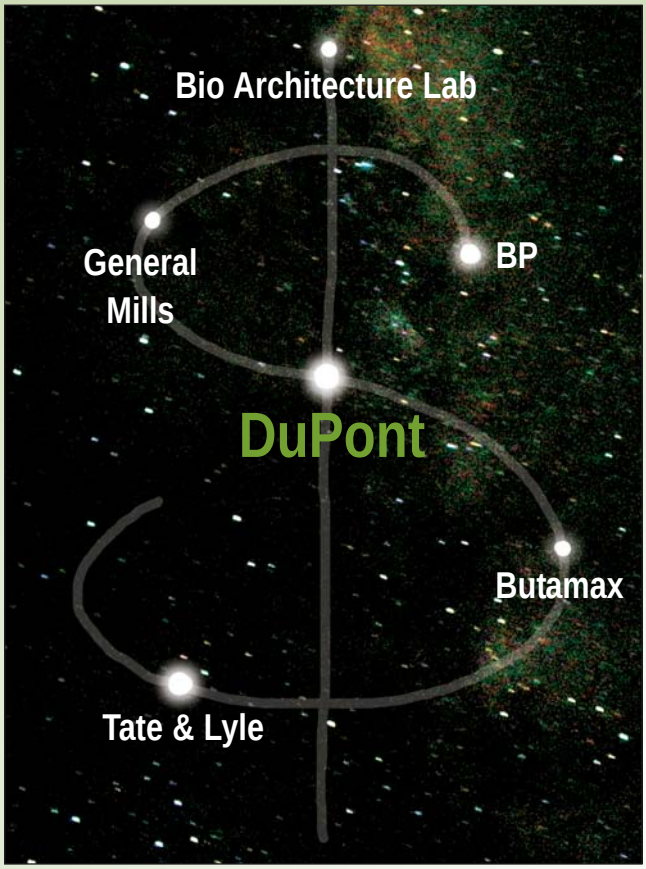
The New Corporate Galaxy

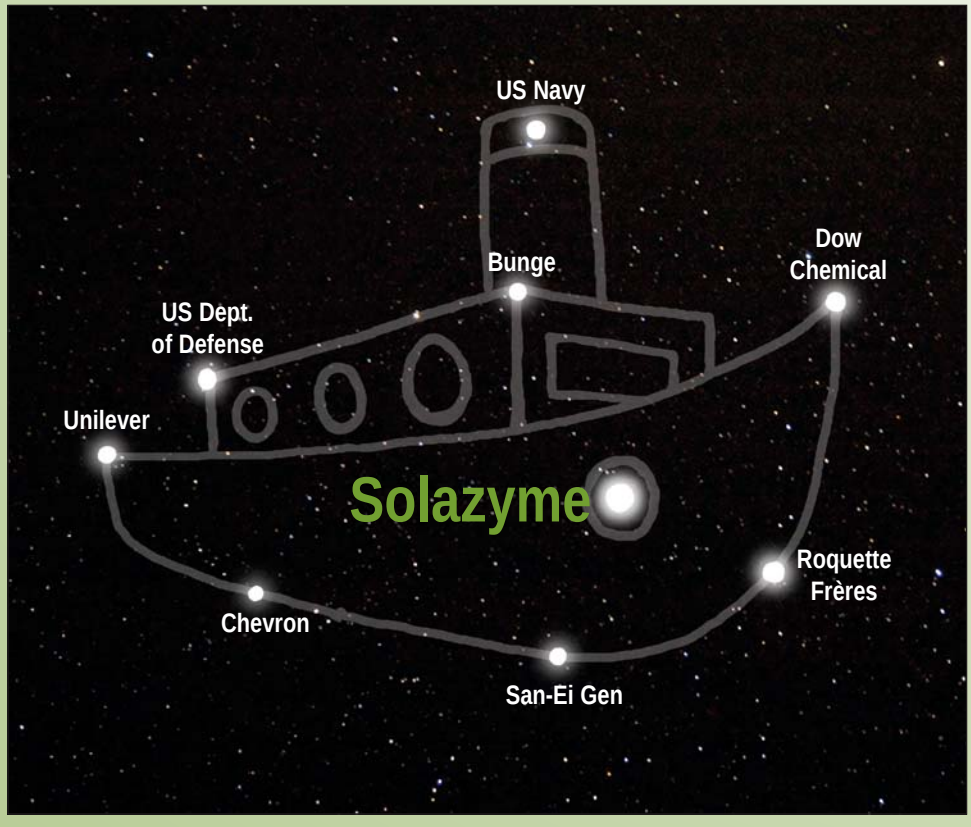
The world's largest companies are converging around biomass in anticipation of a post-petrochemical future. That doesn't mean they're simply grabbing land and natural resources; they're also investing in new technology platforms to transform plant-derived sugars (from food and fibre crops, algae, all kinds of plant matter) into industrial products. The gravitational pull of biomass is creating new constellations of corporate convergence across diverse industry sectors.



Here are four examples:

1. DuPont

1. Chemical giant **DuPont** and Oil giant **BP** have a joint venture, **Butamax**, which aims to commercialize fuels derived from seaweed. In early 2011, DuPont bought **Danisco**, maker of enzymes and specialty food ingredients – the two companies had a pre-existing partnership to produce cellulosic ethanol. DuPont already sells a bioplastic derived from maize. DuPont (**Pioneer**) is the world's 2nd largest seed company and 6th largest pesticide company.

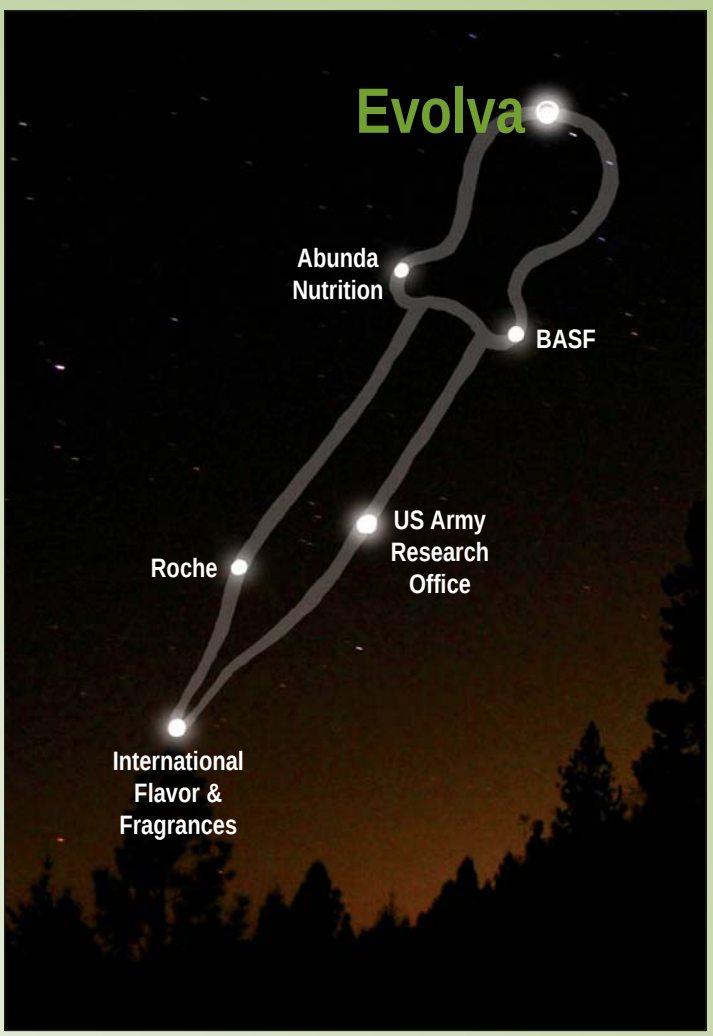


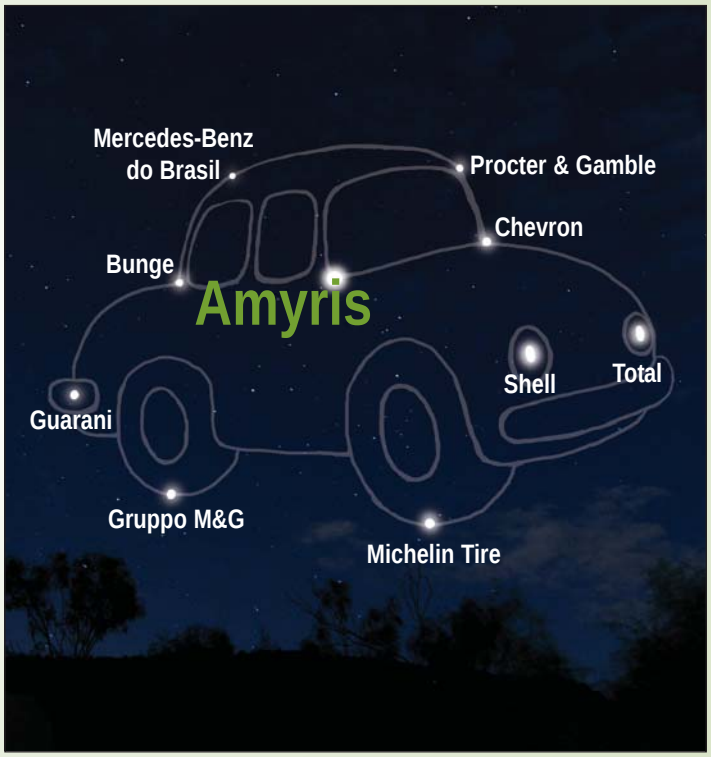
2. Solazyme

Dow Chemical, **Unilever**, **Chevron**, **Bunge Ltd.**, the **US Navy** and **Department of Defense** are all partnering with California-based synthetic biology company, **Solazyme**, which defines its market areas as fuels, chemicals, nutrition and health sciences, and specializes in transforming "low cost plant sugars into high-value renewable oils." Solazyme is also partnering with Japan's **San-Ei Gen** (a major manufacturer and distributor of food ingredients) to develop algae-based food ingredients and has partnered with France's **Roquette Frères** to launch **Solazyme-Roquette Nutritionals**, a joint venture commercializing a suite of algae-derived food ingredients.

3. Evolva SA

Chemical giant **BASF** and pharma giant **Roche** have partnerships with biotech/synthetic biology company **Evolva SA** (Switzerland), which connects its "technologies and product pipeline with companies who have the resources and skills to conduct late stage product development and marketing [and]... share in the value of these products through a mixture of milestone, royalty and supply agreements." Evolva acquired **Abunda Nutrition**, its partner in the quest to synthetically produce vanilla (July 2011) and partners with **International Flavor & Fragrances** to synthetically produce another "key flavouring ingredient." Evolva also partners with the **US Army Research Office** to discover compounds that inhibit the growth of the bacterial pathogen *Burkholderia pseudomallei*.





4. Amyris

Procter & Gamble, **Chevron**, **Total**, **Shell, Mercedes-Benz do Brasil**, **Michelin Tire**, **Gruppo M&G** (plastics manufacturer), **Bunge Ltd**. and **Guarani** are all partnering with California-based synthetic biology company, **Amyris**. According to *Biofuels Digest*, Amyris is "best understood as a web of partnerships, which form the core strategic element in its capital-light, distributed path to market."

Super-Consolidated TNC Control

147 companies controlled nearly 40 percent of the monetary value of all transnational corporations in 2007.[1]

That's the finding of a new study published in July 2011 by researchers at Switzerland's ETH Zürich, based on an analysis of 43,060 transnational corporations (TNCs) located in 116 countries. Just 737 firms account for 80% of the value of all TNCs.

According to the authors: *The interest of this ranking is not that it exposes unsuspected powerful players. Instead, it shows that many of the top actors belong to the core. This means that they do not carry out their business in isolation but, on the contrary, they are tied together in an extremely entangled web of control. This finding is extremely important since there was no prior economic theory or empirical evidence regarding whether and how top players are connected. The top holders within the core can thus be thought of as an economic 'super-entity' in the global network of corporations. A relevant additional fact at this point is that 3/4 of the core are financial intermediaries.*[2] (Financial intermediaries include, for example, investment banks, brokerage firms, insurance companies, etc.)

Overview:

Who Will Control the Green Economy?

Issue

In the lead-up to the June 2012 Earth Summit (Rio+20), the notion of a "great green technological transformation" enabling a "green economy" is being widely promoted as the key to our planet's survival.[3] The big idea is to replace the extraction of petroleum with the exploitation of biomass (food and fibre crops, grasses, forest residues, plant oils, algae, etc.). Proponents envision a post-petroleum future where industrial production (of plastics, chemicals, fuels, drugs, energy, etc.) depends – not on fossil fuels – but on biological feedstocks transformed through high technology bioengineering platforms. Many of the world's largest corporations and most powerful governments are touting the use of new technologies – including genomics, nanotechnology and synthetic biology – to transform biomass into high-value products.

Impact

The greatest storehouses of terrestrial and aquatic biomass are located across the global South, and they are safeguarded primarily by the peasant farmers, livestock-keepers, fisher people and forest dwellers whose livelihoods depend on them. ETC Group warns that the bioeconomy will spur even greater convergence of corporate power and unleash the most massive resource grab in more than 500 years. The corporate "BioMassters" are poised to commodify nature on an unprecedented scale, destroy biodiversity and displace marginalized peoples.

Players

The quest to secure biomass (and the technology platforms that can transform it) is driving corporate alliances and creating new constellations of corporate power. Major players include: Big Energy (Exxon, BP, Chevron, Shell, Total); Big Pharma (Roche, Merck); Big Food & Ag (Unilever, Cargill, DuPont, Monsanto, Bunge, Procter & Gamble); Big Chemical (Dow, DuPont, BASF); and the Mightiest Military (the US military).

Policy

In the face of climate chaos, financial and ecological meltdowns, and pervasive hunger, governments preparing for Rio+20 will be eager to embrace a technological transformation (of any color) that promises a politically expedient Plan B for the planet. But if business as usual is not an option, governance as usual is not an option either. New, more socially and ecologically sustainable economic models are needed to safeguard the integrity of planetary systems for our and future generations. Authoritative and innovative anti-trust mechanisms (that do not currently exist) must be created to rein in corporate power. International policymakers must bridge the current disconnect between food security, agriculture and climate policy – especially by supporting food sovereignty as the overall framework for addressing these issues. All negotiations must be informed by strong participation of social movements and civil society. In the absence of bold action by governments and the creation of new governance structures, the Green Economy will perpetuate the Greed Economy.

What's in this report and why

Where we've been

For more than 30 years, ETC Group (first as RAFI) has monitored corporate mergers & acquisitions (M&As) in the agro-industrial food chain. Throughout the 1970s, we witnessed petrochemical and pharmaceutical companies (e.g., Royal Dutch/Shell, Occidental Petroleum, Ciba-Geigy, Union Carbide, Upjohn Pharmaceutical) scoop up thousands of small, family-owned seed companies. By the 1980s, a "life industry" had emerged – seeds, agrochemicals, pharmaceuticals (both livestock and human) – which became all the more entangled by the development and commercialisation of proprietary biotechnologies (genetic engineering). Corporate concentration in the commercial seed sector meant a dramatic loss of genetic diversity as companies offered only the most profitable lines of seeds for sale and abandoned the rest. Intellectual property regimes (primarily patents and Plant Breeders' Rights) soon extended to all biological products and processes, and further rewarded uniformity. With the privatisation of plant breeding, public breeding programs withered, reinforcing corporate consolidation in the seed and agrochemical industry.

Throughout the 1990s, the life industry was shaken by a dizzying number of M&As and corporate spin-offs. Monsanto, for example, traditionally known as a chemical corporation, merged with pharmaceutical company Pharmacia & Upjohn (which was itself the product of a 1995 merger).[4] Monsanto was spun off as an independent company focusing on agrochemicals and seeds two years later.

Keeping up with corporate M&As is more than just a tedious intellectual exercise, however. M&As mean big money changing hands – 2009 saw 64,981 M&A deals across the globe worth $3.6 trillion[5] – but the implications of the capital shuffle can't be understood in isolation. By the early 1980s, for example, it was well known that the petrochemical industry's motivation for its aggressive and decade-long acquisition of seed companies was to sell seed and agrochemicals together as a package deal.[6] It was a new technology – specifically, the genetic engineering of plants to tolerate proprietary herbicides and pesticides – that turned vision into reality.

Companies are no longer content to control the genetic material found in seeds, plants, animals, microbes and humans (i.e., all living things); they also want to control the reproductive capacity of the planet.

Where we are and where we're going

Today we may be on the cusp of the boldest and most ambitious corporate/techno coup to-date. At the turn of the millennium, the vision of a bio-based economy began taking shape: the capture of living (or recently-alive) matter, referred to as *biomass*, and its transformation into high-value products. The nascent biomass economy quickly acquired a patina of 'green,' promising to solve the problem of Peak Oil, to arrest climate change and to usher in an era of sustainable development.

A diverse group of advocates – governments, corporations, venture capitalists, some NGOs – is promoting the technologies that make (or will make) it possible to convert biomass into commercial products. These technologies include genetic engineering, synthetic biology and nanotechnology. Proponents argue that today less than one-quarter of the Earth's annual supply of terrestrial biomass reaches the commercial market, leaving behind three-quarters of it – primarily in the South – as a green but ripe commodity, ready to be plucked. The resource grab reflected in today's M&As– especially in the South – is largely driven by the quest to achieve "raw material security:" the acquisition of strategic natural resources that include arable land, traditional bulk commodities, mined minerals and metals, and now generic plant material for biomass feedstocks.

Many of the actors promoting the bioeconomy are also calling for market-based mechanisms to allow the quantification and then commodification of the Earth's natural processes, re-branded as 'ecosystem services' (the cycling of carbon, soil nutrients and water, for example).[7] What we're witnessing is the birth of a greatly expanded life industry. Companies are no longer content to control the genetic material found in seeds, plants, animals, microbes and humans (i.e., all living things); they also want to control the reproductive capacity of the planet.

In the absence of effective and socially responsive governance and government oversight, the bio-based, global economy will result in further environmental degradation, unprecedented loss of biodiversity and the disappearance of the remaining commons. It represents an assault on the lives and livelihoods of small farmers, livestock-keepers, forest-dependent people and fisher folk – the communities that feed the majority of the world's population and offer our best hope for combating climate change.

In this report on corporate power, ETC Group expands its traditional focus on the agro-industrial and life industry sectors to encompass the bio-energy, aquafarming, chemical and synthetic biology companies that are elbowing their way into the fold of the life industry. We also examine bio-information companies, which remain largely behind the scenes but are nonetheless indispensable for maximizing biomass – and profits.

How many zeroes?

In this report, ETC Group uses the following numbering system:

One million = 1,000,000

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

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

Note: The corporate rankings in this report are based largely on 2009 revenues. We've used 2009 figures for the sake of greater consistency, allowing for lag time in corporate reporting and variances in fiscal year calendars. (Our last major report on trends in corporate power, *Who Owns Nature?*, was based on 2007 revenues.) Financial results for 2009 are noteworthy because the global crisis of capital is clearly reflected in the numbers; several sectors saw flat growth or even sharp declines in revenue from 2008. But that doesn't mean CEOs and shareholders suffered unduly; on the contrary, corporate profits continued to swell. Looking back on 2009, industry analysts noted with admiration that companies across all sectors somehow managed to "do more with less" (e.g., fewer workers, fewer worker benefits).[8] Not surprisingly, the quest to increase corporate revenues in a depressed market meant pursuing new customers. Capturing emerging markets in the global South – also home to the largest stocks of biomass – remained at the top of company to-do lists.

Control of Surf & Turf

Demand for food, feed and other forms of plant-derived biomass – as well as for strategic resources such as minerals and timber – is driving the international land grab.

Control of water resources is another major driver. Civil society organizations have effectively documented the dangers of massive (and ongoing) land and water grabs across the globe (for example, the international organization GRAIN and Canadian-based Polaris Institute, respectively). Though surveys are not exhaustive, an estimated 50-80 million hectares of land across the global South have been targeted by international investors, and two-thirds of the land deals are taking place in sub-Saharan Africa.[9] As of 2006, 14 million hectares – about 1% of total arable land – was being used for biofuel production. One study estimates that, by 2030, 35-54 million hectares (2.5-3.8% of arable land) will be used for biofuel production.[10]

World's 10 Most Dangerous Land Grabs since 2007

Sources: GRAIN, ODDO Securities, ETC Group

Whose Land?	Who's Grabbing?	When?	How much?
	Country / Company		(Hectares)
1. Sudan[11]	Saudi Arabia / Foras International Investment Company, UAE, Egypt, South Korea, US / Jarch Capital,	2009	~30,000,000
2. Zambia	China	2009	2,000,000
3. Democratic Republic of Congo	South Africa / Agriculture South Africa, China / ZTE	2010	12,800,000
4. Uganda	Egypt	2007	840,000
5. Pakistan	UAE / Abraaj	2009	324,000
6. Tanzania	Sweden and Saudi Arabia	2008	900,000
7. Philippines	China / ZTE	2008	1,240,000
8. Laos	China / ZTE	2007	700,000
9. Indonesia	Saudi Arabia / BinLaden	2008/9	2,100,000
10. Argentina, Paraguay, Uruguay	Guernsey / Global Farming Limited	2008	1,230,000

World's Largest Water Companies

Sources: Polaris Institute, Global Water Intelligence, ETC Group

Company (Headquarters)	What they do	Revenue 2009 (US$ million)
1. Veolia Environnement (France)	Water supply and mgmt., waste mgmt., energy and transport services	49,519
2. Suez Environnement (France)	Water supply, wastewater treatment, waste management	17,623
3. ITT Corporation (USA)	Water supply, treat wastewater, supply pumps etc. for handling toxic water	10,900
4. United Utilities (UK) (FY ending 3/31/2010)	Water supply and sewage treatment	3,894
5. Severn Trent (UK) (FY ending 3/31/2010)	Water supply and sewage	2,547
6. Thames Water (UK) (FY ending 3/31/2010)	Water supply and wastewater treatment	2,400
7. American Water Works Company (USA)	Water supply and wastewater mgmt	2,441
8. GE Water (USA)	Water treatment, wastewater treatment	2,500
9. Kurita Water Industries (Japan) (FY ending 3/31/2010)	Water/wastewater treatment/reclamation, soil and groundwater remediation	1,926
10. Nalco Company (USA)	Water treatment (water-related revenue only)	1,628

Back to the Future?

Even as new industrial platforms involving petrochemicals and electricity were gaining ground in the late nineteenth century, the newly formed United States Department of Agriculture (USDA) unveiled its official seal showing a plow with sheaves of maize depicted on the surface of a shield. Below the shield, an unfurled scroll bears the claim: *AGRICULTURE IS THE FOUNDATION OF MANUFACTURE AND COMMERCE.*

As the 20th century evolved, petrochemicals and their associated technologies displaced agriculture as the economy's foundation, but the 21st century may see a return of agriculture's primacy. The vision is of a transformed and transformative agriculture, however, where both input (i.e., feedstock and feedstock processing) and output are tailor-made for particular industrial uses. Commodity crops may no longer be identified in the traditional way; in the future, they'll be engineered, proprietary products custom-designed to meet the needs of industrial biomass processors – whether for food, energy, materials or pharmaceuticals.

The Great Green Technological Transformation, or *The Greed Economy: Once More With Failure?*

Faced with urgent crises in finance, food and Fahrenheit (climate change), the allure of a technological quick-fix is almost overwhelming: Perhaps nanotechnology could reduce raw material demand and manufacturing costs; synthetic biology could replace fossil fuels and geo-engineering could deflect sunlight and sequester greenhouse gases. While the United Nation's 2011 World Economic and Social Survey, *The Great Green Technological Transformation,* acknowledges that business as usual is not an option, it nevertheless proposes that today's environmental woes could be resolved by technological silver bullets. History suggests that quick fixes don't work. Some recent examples from the energy/chemical industries that highlight the need for broad societal technology evaluation:

"Brewhaha"

In the 1970s and '80s, the most hyped aspect of biotechnology was not the genetic engineering of crops but the potential to use tissue culture and biofermentation technologies to "brew" – in industrial-scale vats – the commercially-valuable parts of plants (fruits, nuts or kernels) or the unique chemical compounds associated with them (flavours, aromas, etc.). Biotech start-up companies were a-twitter with the prospect of eliminating farmers and farmland and deleting climate and geography as factors in production. Coffee, tea, cocoa, vanilla, medicinal herbs and, perhaps someday, even grains and vegetables, would be harvested in Chicago or Hamburg factories. The food would be brewed on demand and on site – with a minimum of energy since only the end-use parts of the plant would be grown. The enthusiasm was backed by "sound science" – i.e., cultures of plant "stem cells" (meristematic cells) showed that it was possible. Industrial magazines were awash in brightly-coloured photographs of test tube beans and beverages.

But it didn't scale up. Life proved more complicated. By the time of the 1992 Earth Summit, this kind of biotechnology was being shelved and companies were back in the field and the lab doing the comparatively humdrum work of developing herbicide-tolerant, genetically engineered crops that would increase sales of their proprietary chemicals.[12]

As it was for biofermentation a quarter of a century ago, will it also be for synthetic biology tomorrow? The similarities are striking. Synthetic biologists now promise they will soon be able to take any kind of biomass and turn it into any end-product merely by dumping the living carbon into a vat and letting their (proprietary) microbes do their duty. All that governments and society have to do is surrender the multi-genome patents, the land and the biomass and put their future in the hands of the industry that failed once before. Or, will life – once again – prove to be more complicated?

Catalytic Alchemy

With the development of industrial catalysis early in the last century, the use of fossilized carbon expanded beyond fuel to provide the key ingredient in a myriad of products (e.g., plastics, pharmaceuticals, materials, etc.). The heyday of the new industrial technology came in the 1950s and 1960s as companies like Standard Oil and Mobil (now merged into ExxonMobil) invented industrial processes that created benzene that, in turn, led to polyester, acrylic fibres (1957), polypropylene (1953), increased the yield from a barrel of oil by 20% (1963) and – most significantly – made new hydrogen processes that substantially expanded the production of ammonia for fertilizers (1962) just as the Green Revolution got underway.[13] Scientists and companies enthusiastically predicted that industrial catalysis would transform the world and make it possible to turn petroleum into virtually anything. Governments and industry invested heavily in catalysis research but, by the 1970s, they were no closer to understanding how catalysis works. Often described as alchemy or wizardry, the breakthrough technology floundered and industry's attention drifted elsewhere. Catalytic processes continue to be integral to the petrochemical industry, and some research continues, but the "miracle" that was once thought to be able to transform all raw materials has faded.

The mystery surrounding the phenomenon of catalysis is not unlike that surrounding nanotechnology today. Just as chemical reactions speed up in the presence of a catalyst, seemingly magically, the properties of elements change as they slip down into the nanoscale and keep on changing the smaller they become. After investing more than $50 billion in nanotech, there is still no global definition, no clear understanding of how nanomaterials will perform and no comprehensive regulatory oversight.[14] Nanotech – the miracle technology of the first decade of our new century – may retain a place in energy and manufacturing, but it is unlikely to have the revolutionary impact hoped-for in tomorrow's Great Green Technological Transformation.

Wind Power Wind Down

Wind power is real and its potential is huge. That said, it is hardly new. The Chinese, Persians and Arabs have all used wind power over thousands of years. Major strides were made by industry in improving the efficiency of wind turbines during the 19th century only to fade away as the internal combustion engine and hydroelectric power pushed aside the notion of local energy self-sufficiency.

The oil crisis of the 1970s brought on a resurgent interest in wind power, along with hefty government subsidies. The USA (most notably, the state of California) and Germany poured money into gigantic and hurried high-tech, top-down wind research programs. In contrast, Denmark took it slow, bottom-up, and continually adjusted designs to reflect experience. Between 1975 and 1988, the US government spent $427.4 million on wind power R&D – 20 times Denmark's $19.1 million investment; Germany invested $103.3 million (five times the Danes' investment), yet Danish manufacturers made better turbines, supplying 45% of total worldwide wind turbine capacity by 1990.[15]

By the late-1980s, the wind power industry in Germany and the United States all but collapsed under the weight of their technological hubris. Virtually the only wind turbines left operating in California by the time of the Earth Summit were Danish.[16] As the engineer's motto goes, "If you want it bad, you'll get it bad."[17] To be clear, the potential to use wind power is substantial but it will be important to proceed slowly, carefully and locally.

Sub-primed Nuclear Stocks

Almost a decade before Rachel Carson wrote Silent Spring, US President Dwight Eisenhower took the podium of the UN General Assembly to announce his "Atoms for Peace" program to develop nuclear power plants as a safe, clean technology that would electrify our lives and bring the planet's people out of poverty. The race was on. One part of the race related to governance. UN agencies – especially UNESCO – rushed to claim intergovernmental authority over nuclear power but in the unseemly squabble that followed, lasting several years, the United States ultimately opted to create the International Atomic Energy Agency. The second and bigger race was to design and build power plants. The globalisation of nuclear power was an important part of Cold War public relations and the United States encouraged private companies to adopt the same design used by its nuclear submarines. It would have been hard to come up with a less appropriate design. The dominant features of submarine nuclear technology were portability and long-term self-sufficiency. Portability, of course, was irrelevant to domestic commercial power plants. By the 1970s, the wheels were coming off the nuclear juggernaut as production costs skyrocketed, safety concerns multiplied and, in the United States, at least, desperate retro-fitting of regulations – mushrooming daily – confounded the industry.[18] When Chernobyl in 1986 followed Three Mile Island in 1977, the industry froze.

Global warming gave nuclear power its second wind at the turn of the century. By 2010, 65 countries lined up for nuclear power and the industry was predicting a boom.[19] On March 11, 2011, Fukushima changed everything. Industry hubris exacerbated the situation. It turned out that TEPCO, the company that built the plant in the mid-1960s, razed 25 metres of the 35-metre natural seawall where the reactors were to be located, in order to make it easier to move heavy equipment from boats to the construction site.[20] While the company defended the decision to re-engineer the landscape by arguing there had been no historic precedent of tsunami damage to the area, a seismologist investigating the disaster points out, "Of course there is no record of big tsunami damage there because there was a high cliff at the very same spot." When the public learned that fully 88 of the world's 442 nuclear power plants[21] are built on seismic fault lines, the jig was up. Beyond the human devastation, the financial cost of improper technological evaluation for Japan's recovery – as estimated two months after the disaster – will come to at least $124 billion.[22]

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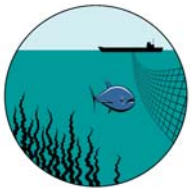

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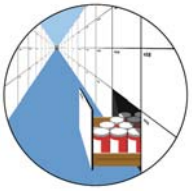

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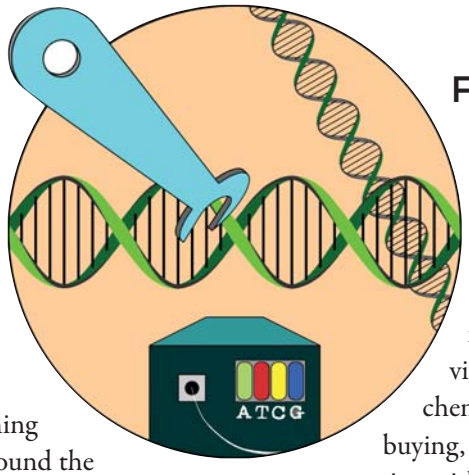
Synthetic Biology



The term *biomass* narrowly refers to the weight of living matter (plants, animals, bacteria, fungi, etc.) found in a specified area, but is more often used to mean non-fossilized biological material that can serve as a feedstock for the manufacture of bio-based products. The term implies a particular way of thinking about nature: as a commodity—even before it enters the commercial market. In other words, everything living is a potential article of commerce. Around the world, industry and governments are turning to biomass – touting it as a solution to climate change as well as a means to increase production, especially energy production.

Meanwhile, the field of synthetic biology has rapidly overshadowed transgenics – where single genes are transferred from one organism to another (as in genetically-modified crops, for example). Synthetic biology companies are engineering synthetic DNA to custom-build algae and microbes that behave as tiny "biological factories."
The aim is to convert almost any biomass into almost any product. With billions of dollars of public and private investment over the past few years (including the world's largest energy and chemical companies), synthetic biology sees nature's biodiversity as a feedstock for its proprietary bugs – designer organisms that will be used to transform plant cellulose into fuels, chemicals, plastics, fibres, pharmaceuticals or even food – depending on market demand at harvest time. The new "BioMassters" see synthetic biology as the route to an additional revenue stream – a "green" complement to petroleum-based production, or possibly its replacement in the distant future.

Follow the Money

In the past five years, synthetic biology has moved from being a "fringe" science – a hybrid of engineering and computer programming, rather separate from biology – to an area of intense industrial interest and investment. Consolidation is visible in the form of established energy, chemical and pharmaceutical companies buying, making strategic investments in or partnering with pure play synthetic biology (syn bio) companies, which are, generally, start-ups operating in 'stealth mode' (few are publicly traded).

Synthetic biology is not a discreet technology sector, but a set of tools that is being integrated into many industry sectors. It's not easy to get a handle on the syn bio market. BCC Research valued the synthetic biology market at a mere $233.8 million in 2008 and predicts an almost 60 percent annual growth rate to $2.4 billion in 2013.[23] Global Industry Analysts, Inc. expects the market to swell to $4.5 billion by 2015, noting that what began as a North American and European industry is gaining traction in Japan, China and other Asian countries.[24]

The synthetic biology industry currently breaks down into two types of companies: companies that provide synthetic DNA and lab-level tools (reagents, microarrays, DNA "chips") and those that use synthetic DNA and tools to design, create, test and commercialize engineered organisms for applications and products aimed at the consumer market.

Synthetic Biology's Key Players

Gene Synthesis and Tools	Applications
Agilent Technologies (USA)	Amyris Biotechnologies (USA)
Epoch Life Science, Inc. (USA)	Genencor/Danisco (now DuPont)
454 Life Sciences/Roche Diagnostics (USA)	Sapphire Energy (USA)
Geneart/Life Technologies (Germany)	Synthetic Genomics, Inc. (USA)
febit (Germany)	Solazyme, Inc. (USA)
DNA 2.0 (USA, Switzerland)	Metabolix (USA)
Blue Heron Biotechnology (USA)	Chiron Corporation (now part of Novartis Diagnostics Global)
Sangamo BioSciences (USA)	Draths Corporation (USA)
Gingko Bioworks (USA)	Evolva SA (Switzerland)
Intrexon Corporation (USA)	Chromatin, Inc. (USA)
GEN9, Inc. (USA)	LS9 (USA)

The Parts of Life

While companies such as **Blue Heron**, **febit** and **DNA 2.0** continue to crank out ever-longer lengths of synthetic DNA as an ever-cheaper commodity, the new heavyweight on the block is **Life Technologies Corporation**, formed by the late 2008 merger of two already powerful lab-tool companies, **Applied Biosystems** and **Invitrogen**. With more than $3.6 billion in revenues in 2010 and 11,000 employees worldwide, Life Tech has been expanding both vertically and horizontally. The company has acquired a controlling (75%) stake in the world's largest gene synthesis company, **Geneart**, an equity stake in **Synthetic Genomics, Inc.**, acquired **BioTrove** and **AcroMetrix** (genotyping analysis and molecular diagnostics companies, respectively) and inked an exclusive deal with **Novici Biotech**, a synthetic biology tool-smith that sells an error-correction kit to synthetic DNA manufacturers.

The wildcard in the "tools" kit is **Intrexon**, a privately held company that claims to have an extensive library of modular DNA parts that can be assembled as part of its industrial scale, "Better DNA" platform. Like Life Tech, Intrexon has been shopping – acquiring companies with expertise in disease diagnostics (**Avalon Pharmaceuticals, Inc.**), agricultural biotechnology (**Agarigen**) and forming a strategic partnership with cancer drug developer **Ziopharm, Inc**. New start-up **GEN9**, founded by high-profile Harvard, Stanford and MIT researchers, rose from the ashes of pioneer syn bio company Codon Devices, which folded in 2009.

The syn bio applications area is exploding. Early adopters **DuPont** and **ADM** are already selling their bioplastics derived from corn sugars. **Genencor**, which DuPont bought for $3.6 billion in January 2011, and **Metabolix** were the syn bio brains behind the Sorona (DuPont) and Mirel (ADM) plastics. Genencor also has an ongoing agreement with Goodyear to develop synthetic rubber for tyres. In pharmaceuticals applications, **Novartis** looms large. Not only does its 2006 acquisition – **Chiron Corporation** – hold key patents in synthetic biology, but it also has a high-profile collaboration with Synthetic Genomics, Inc. to develop flu vaccines.

Fueling Interest in Syn Bio

Most syn bio companies, however, are focusing on energy or chemicals, or both. Syn bio-based fuels and chemicals brought in $80.6 million in 2008; that figure is expected to grow to $1.6 billion in 2013, according to BCC Research.[25] **Amyris Biotechnologies** and **Synthetic Genomics, Inc.** have amassed the larger war chests of investors, partnerships and market hype.

Sugar Daddies

Industry tracker *Biofuels Digest* ranks the top companies in Bio-based Chemicals, Materials and Biofuels, which includes not just high-tech start-ups like Amyris, Solazyme, etc., but also the world's biggest corporate players, such as ExxonMobil, Monsanto, Cargill, DuPont and Dow.

Biofuels Digest's "Hottest Companies in Renewable Chemicals and Biomaterials" for 2011-12: [26]

1. Genomatica
2. Solazyme
3. Amyris
4. Gevo
5. LS9
6. DuPont
7. Codexis
8. Genencor (DuPont)
9. Novozymes
10. ZeaChem
11. Cargill
16. Dow Chemical
20. DSM
25. DuPont Danisco

Biofuels Digest's "Hottest Companies in Bioenergy" for 2010-11: [27]

1. Amyris
2. Solazyme
3. POET
4. LS9
5. Gevo
6. DuPont Danisco
7. Novozymes
8. Coskata
9. Codexis
10. Sapphire Energy
18. Genencor (DuPont)
30. Synthetic Genomics
35. ExxonMobil
48. Chevron
49. Monsanto

Amyris in particular boasts a list of partners ranging from **Procter & Gamble** to **Shell**, **Total** (oil and gas), **Bunge Ltd.**, **Cosan S. A.** (Brazil), **Mercedes** and a host of leading but lesser known chemical, cosmetics, plastics and fragrances companies. Synthetic Genomics, Inc. may not have sold any products yet, but its high profile announcement of "Synthia" – a self-replicating bacterial cell with an entirely synthetic genome – and the ongoing media attention paid to founder Craig Venter has helped it close deals (both equity investments and R&D partnerships) with **Exxon**, **BP** and Malaysian palm oil conglomerate, **Genting Group** for undisclosed sums. In March 2011, **Dow Chemical** announced it would buy 20 million gallons of synthetic oil for electrical applications from California, USA-based Solazyme. Solazyme produces the fluid from sugar-eating algae.

Commercial Ag Makeover?

While agriculture already looms large in syn bio's world – as a consumer of agricultural feedstocks – agriculture itself is also a growing target for syn bio applications. Both **Solazyme** and Synthetic Genomics are engineering algae to produce a palm oil substitute. Solazyme's research is in collaboration with **Unilever**, which also invests in the company, along with agribusiness giant **Bunge Ltd**. and Japan's **San-Ei Gen** (a leading food ingredient manufacturer). In early 2011, Swiss company **Evolva** announced a new partnership with **BASF** to produce agrochemicals. Weeks later, **Evolva** announced it would acquire **Abunda Nutrition**, its R&D collaborator in synthetically producing ingredients such as vanilla.

The new "BioMassters" see synthetic biology as the route to an additional revenue stream – a "green" complement to petroleum-based production, or possibly its replacement in the distant future.

It's not the first time that researchers have tried to employ new biotechnologies to displace natural, high-value tropical commodities.[28] In March 2011, **Monsanto** announced it would both invest in and collaborate with US-based **Sapphire Energy**, another algal oil producer. Monsanto is interested in algae because of what it might reap for agricultural applications, in the form of traits.[29] Sapphire's CEO Jason Pyle explains the appeal of the partnership for his company: "The biggest thing Monsanto brings is that it solidifies our hypothesis, that [in order to solve the problem of fossil fuels] you have to expand the resource base. It can't be about simply changing one thing into another. You have to create a new commercial agriculture."[30]

Global Energy Giants Inching towards Bioeconomy

Industry statistics on world energy consumption put the "Green Economy" in much-needed perspective: In 2010 the world's energy consumption grew by 5.6% - faster than any year since 1973.[31] Fossil fuels accounted for 88% of the world's primary energy (oil 34%; coal 30%; gas 24%). Nuclear, hydroelectric and "renewables" account for the remaining 12%. Non-hydro "renewables" (wind, geothermal, solar, biomass and waste) – including biofuels – account for 1.8% global energy consumption. *World biofuels production grew by 14% in 2010 – but accounted for just one-half of one percent of global primary energy consumption.*[32] The world's top 10 energy companies account for 25% of the estimated $7 trillion energy market. Many of the world's largest energy enterprises are high-profile investors in synthetic biology. Not only do they seek a cleaner, greener image; they believe that future profits will depend on diversifying and controlling bio-based feedstocks for energy production.

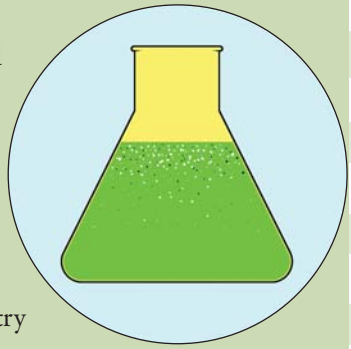
World's Top 10 Energy Companies

Sources: Platts, ETC Group

Company (Headquarters)	Revenue 2009 (US$ million)
1. Royal Dutch Shell (Netherlands)	278,188
2. ExxonMobil Corporation (USA)	275,564
3. British Petroleum (UK)	239,272
4. China Petroleum & Chemical Corporation (China)	192,638
5. Chevron Corporation (USA)	159,293
6. Total SA (France)	157,673
7. PetroChina Company (China)	149,213
8. E.ON AG (Germany)	115,772
9. Petrobras (Brazil)	100,880
10. Gazprom Oao (Russia)	98,135
Total Revenue of Top 10	**1,766,628**

Biofeedstocks for Industrial Chemical Production

The world's 50 largest chemical corporations control a global market valued at $697 billion in 2009. The top 10 chemical firms account for about 40% of the market. "Petrochemicals," by definition, are derived from petroleum and other fossil fuels. With soaring costs, unpredictable supplies and more challenging extractions, the industry is already making a transition from petrochemicals to biomass feedstocks. (In 2010, the world's top 50 chemical corporations rebounded with combined sales of approximately $850 billion, an increase of 25.3% over 2009.[33])



World's Top 10 Chemical Companies

Source: Chemical & Engineering News

Company (Headquarters)	2009 Chemical sales (US$ million)	% Share of Total Global Sales
1. BASF (Germany)	54,817	7.8%
2. Dow Chemical (USA)	44,875	6.4%
3. Sinopec (China)	31,312	4.4%
4. Ineos Group (England)	28,600	4.1%
5. ExxonMobil (USA)	26,847	3.8%
6. DuPont (USA)	25,960	3.7%
7. Formosa Plastics Group (Taiwan)	25,437	3.6%
8. Royal Dutch/Shell (Netherlands)	24,437	3.5%
9. SABIC (Saudi Arabia)	23,096	3.3%
10. Total (France)	20,521	2.9%
Total Sales of Top 10 Companies	**305,902**	
2009 Top 50 Global Sales	697,000	43.5%

Size of Global Markets by Sector, 2009 (US$ Million)

Sources for market size are provided in the individual sector analyses within this report.

Conventional wisdom says the size of the global energy market weighs in at $7 trillion and dwarfs every other economic sector. According to our research, however, the global grocery market ekes out ahead of energy – even when government subsidies paid to producers for energy and agriculture are taken into account. According to the OECD, global subsidies of fossil fuel production are about $335 billion (with developing countries accounting for the majority); OECD countries, which account for the vast majority of global agricultural subsidies, paid $253 billion in "producer support" in 2009. It's no surprise, then, that today's BioMassters are now focused on tapping into the profit potential offered by the green economy's marriage of agriculture and energy.

Jurassic Green

The Return of the Dinosaurs: *Once More with Fueling?*

Wall Street describes the energy industry as the "Mother of all Markets." Until about 200 years ago, however, the energy industry and the biomass industry were essentially one. We heated our homes with firewood; fueled our horses and oxen with hay; and lit our pathways with whale blubber. The steam engine and, later, the internal combustion engine turned the energy market from living carbon to fossilized carbon as coal and then petroleum and natural gas took center stage in our anything-but Green Economy. Whatever our fields and forests could do, we discovered, could be done by dinosaurs and the food they once ate (i.e., ancient carbon).

But the energy industry (including petrochemicals) never lost interest in living carbon and "alternative" energy sources. ExxonMobil (then Standard Oil of New Jersey) positioned itself to control agricultural inputs turning petrol stations into farm supply centres including fertilizers and chemicals. With the oil crisis of the early 1970s, Shell Oil, Occidental Petroleum, Atlantic Richfield and Union Carbide all moved into seeds. In the late '70s and early '80s, Shell bought more than 100 seed companies and briefly became the world's biggest multinational seed enterprise.[34] In the early days of biotechnology, petrochemical and pharmaceutical companies sought new ways to monopolize living carbon – less through the control of crops – more through biofermentation processes that, they theorized, would move agricultural production from fields to factories.

The combination of Peak Oil, BP oil spills and, especially, alarm over greenhouse gases and climate change have made the future profitability of fossil carbon more challenging and so the dinosaurs are returning to their historic habitat.

Galvanized by the oil crises and the Club of Rome's *Limits to Growth* predictions, the energy market also moved to wind and nuclear power.

By the mid-1980s, the bloom was off energy's first Green Economy. Oil prices fell; biofermentation proved itself either premature or impossible; wind power failed to scale up and nuclear power ran aground at Three Mile Island and Chernobyl. (See box, *The Great Green Technological Transformation,* page 4) The oil majors dumped seeds and went into deep-sea drilling. Only chemical companies like Monsanto and DuPont (and, later, Syngenta) stayed to reap the monopoly profits from using biotech to merge their pesticide and seed sales.

But now they're back. The combination of Peak Oil, BP oil spills and, especially, alarm over greenhouse gases and climate change have made the future profitability of fossil carbon more challenging and so the dinosaurs are returning to their historic habitat. Whatever fossil carbon can do, they assure us, living carbon can do as well. Instead of biotech and biofermentation, there is now synthetic biology promising to convert any kind of biomass into any kind of plastic, chemical, fuel or (even) food. Enter the Green Economy 2.0. ...or, *the Greed Economy times 2.* The potential profits from merging fossil carbon and living carbon are huge. The energy market weighs in at about $7 trillion per year but the agricultural/biomass economy rings up at least $7.5 trillion in annual sales. Wall Street got it wrong: if energy is the Mother of all Markets, agriculture (or biomass) is the Fodder.

Bioinformatics and Genome Data Generation

Ten years ago the first human genome was sequenced and published in draft form – a feat that took 10 years, thousands of researchers and 2.3 billion dollars. In 2008, James Watson's genome became the first human genome to be sequenced for less than $1 million (and one of many "celebrity genomes" to follow).

In early 2011 the CEO of Complete Genomics Inc. claimed that his company is sequencing up to 400 genomes per month, and expects to be "in the vicinity of 1,000 genomes per month" by the end of 2011.[36] The company is offering its human genome sequencing service for $9,500 per genome (with a minimum order of eight genomes).

Who's Got the Biomass?

Satellites and aircraft are now being used to map and monitor tropical biomass in ways previously unimaginable. Cameras mounted on planes can use "hyperspectral imaging" to analyse visible and infrared wavelengths that reveal variations in vegetation.[37] Precise light measurements expose soil nutrients identifying not only the type of surface vegetation but also what lurks beneath. The technology was originally developed to find human burial sites, but has branched out to serve a multitude of interests from archaeologists to the CIA, and now facilitates the privatisation and commercialisation of biomass.

In September 2010, the Carnegie Institution at Stanford University announced that, with World Wildlife Fund and the Peruvian government, it had mapped over 16,600 square miles of Amazonian forest (about the area of Switzerland).[38] While satellites mapped vegetation and recorded disturbances, an airplane deploying Carnegie's proprietary LiDAR technology (light detection and ranging) created maps of the area's 3-D vegetation structure. Scientists converted the structural data into carbon density aided by a modest network of field plots on the ground. Carnegie's novel system brings geology, land use, and emissions data together to advise Peru – and anyone else with access to the data – that the region's total forest carbon storage weighs in at about 395 million metric tonnes with emissions of around 630,000 tonnes per year. (The Intergovernmental Panel on Climate Change [IPCC] estimate for carbon storage in the surveyed area was 587 million tonnes.) The system is also cheap. Peru's map costs $0.08 per hectare and a similar map in Madagascar was only $0.06.[39]

> ***"Life is sequence. Life is digital."***
> – Dr. Huanming Yang, co-founder of China-based BGI, the largest genome sequencing center in the world.[35]

The biopiracy implications of these new mapping / monitoring technologies are substantial. The near-term possibilities include the aerial identification of crops or livestock with unique genetic traits or DNA markers and (importantly for indigenous and local communities) the opportunity to triangulate on soils, microbes or plants offering industrial uses. After it is pinpointed and pocketed, the biodiversity and its land can be used for other purposes. It may be possible for industry or governments to cherry-pick the biodiversity they currently regard as important while discounting and discarding the rest. Further, the technology may allow the tracking of the people in the forest influencing land rights negotiations. The ability to assess the total biomass will add fuel to attempts to manage the environment and climate through market-based "ecosystem services" schemes such as REDD (United Nations Collaborative Initiative on Reducing Emissions from Deforestation and forest Degradation).

The pace and scale of bio-informatics wizardry – though remarkable – is not without complications. Bruce Korf, the President of the American College of Medicine observes, "We are close to having a $1,000 genome sequence, but this may be accompanied by a $1,000,000 interpretation."[40] In other words, what good is a read-out of your personal genome if no one knows what it means? When the founder of Helicos Biosciences sequenced his own genome in 2009, the editor of *Bio-IT World* noted that it took more than 30 experts to annotate and interpret the findings. And while gene sequencing is exponentially faster and cheaper, it's far from perfect. A recent study reveals more than 1.1 million sequence errors on the same human DNA sample using two different sequencing platforms.[41]

Genomics is just one part of a much bigger life sciences sector – a sector that depends on technologies that generate, store, process and analyze information. Whether used for personal genomics, synthetic biology, agbiotech, bioenergy or drug development, the common denominator is massive amounts of biologically-derived data. *Bioinformatics* refers to the management and analysis of biological data using computing techniques.

With rapid advances in sequencing technologies and more powerful computing, the lines between drug development, bioinformatics, sequencing and diagnostics are blurring. Roche and IBM announced a partnership in 2010 to develop next-generation DNA sequencing based on "nanopores" – where DNA molecules are threaded through a nanometre-sized pore in a silicon chip for decoding – with IBM contributing expertise in IT, microelectronics and computational biology, and Roche contributing expertise in medical diagnostics and genome sequencing.[42] Companies known primarily as instrument makers are buying drug developers – such as the Invitrogen's 2008 takeover of Applied Biosystems to form Life Technologies, Inc. Pharmaceutical giants are partnering with DNA sequencing powerhouses, such as Merck's collaboration with China's BGI – the world's largest genome center. Genomics companies are partnering with synthetic biology labs. According to Agilent's CEO, "Synthetic biology potentially can have as profound an impact in the 21st century as semiconductor technology had in the twentieth."[43] The table below examines some of the leaders in DNA data generation.

Major Players in DNA Data Generation

Company (Headquarters)	2009 Sales	Comment
Danaher (USA)	$13.2 billion	Sells "bioanalytical products that detect biology, decode data, and drive discovery." Acquired MDS Analytical Technologies in 2009; acquires Beckman Coulter for $6 billion in 2011.
Roche Diagnostics/454 (Switzerland)	$9.7 billion	Roche acquired 454 Life Sciences in 2007. In 2010 Roche and IBM announced a partnership to develop nanopore next-generation sequencing technology known as "single molecule sequencing."
Agilent Technologies (USA)	$4.5 billion	Provides tools for electronic and bio-analytical measurement. In April 2011 announced multi-million dollar partnership (in form of funding, expertise and infrastructure) with UC Berkeley's new Synthetic Biology Institute (SBI).
Life Technologies (USA)	$3.3 billion	Invitrogen and Applied Biosystems merged to form Life Technologies in 2008. Acquired Ion Torrent's Personal Genome Machine in 2010.
PerkinElmer Life and Analytical Sciences, Inc. Subsidiary of PerkinElmer (USA)	$1.8 billion (entire company)	Provides drug discovery, genetic screening and chemical analysis instrumentation, reagents and services for scientific research and clinical applications. Sells gene sequencing services using Illumina's HiSeq 2000 system. In May 2010 acquired SGL Newco, Inc., the parent company of Signature Genomic Laboratories, LLC.

Company	2009 Sales	Comment
BGI (formerly Beijing Genomics Institute) (China)	Not Available	World's largest genome center, founded in 1999. Privately held; employs 3,000 people across five centers in mainland China and three international centers. 128 sequencers in its Hong Kong facility. BGI has more sequencing capacity than all US academic facilities combined.[44] Sells sequencing, bioinformatics, diagnostics services; active in biofuels and agriculture. In mid-2010 BGI and Merck announced collaboration.
Bio-Rad (USA)	$1.8 billion	Its Life Science Group develops, manufactures and markets laboratory instruments, apparatus, and products used for research in functional genomics, proteomics and food safety.
Illumina (USA)	$662 million	Provides technologies for studying genetic variation and function; tools for DNA, RNA and protein analysis for disease research, drug development, and the development of clinical molecular tests.
Affymetrix (USA)	$327 million	Provides genomic analysis tools and reagents for discovery, exploration, validation, and genetic testing.
Caliper Life Sciences (USA)	$130 million	Provides instruments, software and reagents, laboratory automation tools and analytical services to pharmaceutical and biotech companies for diagnostics and drug discovery.
New Start-ups Developing "Third Generation" Sequencing Technologies		
Complete Genomics (USA)	$0.6 million	Opened for business in May 2010; sells sequencing services through a commercial-scale genome center.
Pacific Biosciences (USA)	$0.1 million	Developing a "third generation sequencing technology" that reportedly can analyze a single molecule of DNA.
Oxford Nanopore Technologies (UK)	N/A	Developing proprietary technology platform for the analysis of single molecules; potential applications include DNA sequencing, protein analysis for drug development or diagnostics, defense, environmental monitoring, etc.
Helicos Biosciences (USA)	N/A	Went public in 2007; filed lawsuit against Pacific Biosciences for patent infringement in 2010.

Commercial Gene Synthesis Companies

There are hundreds of companies that specialize in commercial DNA synthesis. In 2008, ETC Group compiled a list of the leading companies (see below). Two of the companies (GeneArt AG and Blue Heron Biotech) were recently acquired by larger life science companies.

Company (Headquarters)	Comments
GeneArt AG (Germany) http://www.geneart.com http://www.lifetechnologies.com/home.html	Since April 2010, US-based Life Technologies Corp. is the majority shareholder of GeneArt AG.
Blue Heron Biotech (USA) http://www.blueheronbio.com/ http://www.origene.com	Founded 1999; as of August 2010, Blue Heron became a wholly owned subsidiary of OriGene Technologies, Inc. – "a gene-centric life sciences company."
DNA 2.0 (USA) https://www.dna20.com	Founded in 2003; privately held.
GenScript (USA) http://www.genscript.com	Privately held; sells services including bio-reagent, bio-assay, lead optimization, and antibody drug development.
Integrated DNA Technologies (USA) http://www.idtdna.com	Founded 1987; manufactures and develops products for research and diagnostic life science market.
Bio S&T (Canada) http://www.biost.com/	Privately held; sells products and services in genomic research.
Epoch Biolabs (USA) http://www.epochbiolabs.com	Develops and sells reagents for the isolation, expression, analysis and purification of genes and their protein products.
Bio Basic, Inc. (Canada) http://www.biobasic.com/	Founded 1990; privately held. Products/ services include custom oligos; gene synthesis; peptide synthesis; DNA sequencing; protein purification/expression.
BaseClear (Netherlands) http://www.baseclear.com/	Genomics research; processes samples using the Roche NimbleGen SeqCap EZ and the Illumina HiSeq2000 (two major sequencing platforms).

The "Big Data" Deluge

"Big Data" isn't just a Silicon Valley buzzword; it's a colossal challenge for life science companies (and many other industry sectors). The challenge is to store, manage and analyze the massive amounts of DNA sequence data spewing from faster, cheaper gene sequencers and genomics tools – and to mine this information for commercial value (whether for pharmaceuticals, agriculture, energy, etc.).

"The data is growing so fast, the biologists have no idea how to handle this data,"
- Guoquing Li, associate director, Bio-Cloud Computing Department for China's BGI – the world's largest genomics center.[45]

The human genome consists of about 3 billion DNA letters – roughly equal to the size of the English-language version of Wikipedia.[46] A single computer can handle a single genome (about three gigabytes of computer data storage space are required – 1 gigabyte is 1,000,000,000 bytes). But it won't be long until a single sequencing machine will generate 100 gigabytes of data in a few hours.[47] So-called next generation DNA sequencers can spit out close to 90-95 billion bases in a single run.[48] To analyze a genome, however, it's necessary to pinpoint genetic variations and compare findings with other genomes. The avalanche of biological information is creating a big headache for companies that don't have the computational capacity to make sense of the data. Terabytyes used to be considered big data, now companies are shuffling multi-terabyte and multi-petabyte sizes that require more sophisticated handling. (1 terabyte is 1 trillion bytes of data; 1 petabyte is one thousand terabytes – 1 followed by 15 zeros.) As IBM puts it, "there's no such thing as infinite capacity, even with storage media and management advances."[49] That's why we're seeing the emergence of enterprises that are scrambling to provide "information infrastructure technology."

Not so long ago, massive data sets were handled by super-computers and computer clustering (involving groups of computers linked in networks). Today, various forms of "cloud" computing, supported by sophisticated software services, are rapidly becoming the new business model for handling Big Data at high speed.

How Big?

Industry start-up Cycle Computing recently provided computational services to Genentech/Roche for processing protein analysis data. To complete the task, Cycle Computing reportedly harnessed more cloud computer capacity than the 115th-ranked computer on the Top 500 supercomputing list.[51] The job ran for eight hours, utilizing 10,000 core clusters, 1,250 servers, and approximately 8.75 Terabytes RAM aggregated across all machines.[52]

With cloud computing, any computer connected to the Internet can access the same pool of computing power, applications and files. Cloud computing decentralizes computing power because anyone with a credit card can order the hardware and software needed to process or store their data, and send it back to the cloud when the job is finished. Rather than build in-house computing infrastructure, a growing number of life science and biotech companies and academic/scientific institutes are outsourcing data processing and storage needs to cloud services companies (known as IaaS – infrastructure-as-a-service). Because of industry concerns about data security and intellectual property, however, the largest companies are opting to establish private clouds with firewall protection, while contracting for cloud-based applications and services (known as SaaS – software-as-a-service). According to one industry analyst, the market for worldwide cloud services (including infrastructure, platform and software) will explode from $58 billion in 2009 to $149 billion in 2014.[50]

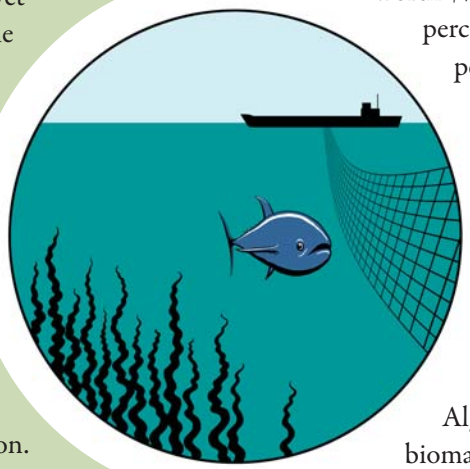
Cloud computing started to soar when Google developed MapReduce, a patented software program that breaks-down large data sets into smaller segments and supports the analysis of large data sets on clusters of computers. According to some analysts, an open-source technology called Hadoop (developed by Yahoo) is "the flagship technology for storing and processing large amounts of unstructured data"[53] and has been a key element in enabling cloud computing for life sciences (using Hadoop-enabled proprietary software and services).

The industry leader in cloud computing is Amazon Web Services; other big players in the information management "ecosystem" include Google, Microsoft, IBM and Hewlett Packard. Smaller players include industry start-ups like Bio Team, Cloudera, Cycle Computing and Geno Logics.

"The Blue Economy:" Marine and Other Aquatic Biomass

Aquatic Ecosystems and the Bioeconomy

Biomass found in oceans and aquatic ecosystems accounts for 71% of the planet's surface area. That's why would-be BioMassters are looking to the wild, wet frontier for new sugars and oils to fuel the bio-based economy. Indeed maritime states are already promoting the green economy's aquatic equivalent: the so-called blue economy, in which natural products from the ocean are "sustainably" exploited to drive economic growth. Small island states may not have much land, but some view their long coastlines and broader EEZ (exclusive economic zone) as potential wealth for biomass production. As the representative from Fiji reminded delegates at a Rio+20 preparatory meeting recently, "we are not 'small island' nations, but 'large ocean' nations."[54]



The Blue Economy

Recoverable marine and aquatic biomass (including biomass in lakes, rivers and coastal estuaries) for industrial uses includes both animals and plants. The animals are mostly fish, including cetaceans (mammals adapted to marine life – around 0.8-2 billion tonnes globally per year) as well as crustaceans such as shrimp and krill. The marine plants are largely algae, including seaweeds (macroalgae) and blue green plankton (microalgae). Microalgae generally refers to algae that aren't visible to the unaided eye. Another source of seawater-based plant biomass is "halophytes" – that is, salt-tolerant plants such as mangroves or the salicornia weed for which there is growing industrial interest. Currently there is no unified "aquatic biomass" industry. However, three industry sectors are well positioned to move into the field: 1) algae (primarily seaweed); 2) aquaculture; and 3) commercial fishing.

The Seaweed and Algae Sector

Companies that farm seaweed and algae are the most active developers of aquatic biomass. Global commercial production of all algae was almost 16 million tonnes in 2008 in a market worth $7.4 billion that is growing at close to 8 percent per year – almost all of which (99.6 percent by quantity) is seaweeds.[55] While seaweed is currently harvested primarily as a source of food (e.g., nori and wakame) or for industrial extracts known as hydrocolloids (thickening agents, for example, carageenen, xanthem and alginate), microalgae is still only a very small market – mostly providing for food ingredients and animal feed.

Algae are attractive as a source of industrial biomass for several reasons:

- Algae are extremely fast growing. Some kelp grow up to two feet per day; micro algae can double in weight daily.
- Algae are a source of carbohydrates (sugars), but do not contain difficult-to-breakdown substances such as lignin.
- Algae are high yielding and concentrated. Wild stands of brown seaweed can produce between 16-65 kg of biomass per square metre per year. By contrast, the most productive terrestrial crops such as sugarcane produce only 6-18 kg of biomass per square metre per year.[56]
- Microalgae produce valuable oils that comprise about one-third of their mass.

Almost 90 percent of seaweed is cultivated rather than harvested from the wild. In 2008, six Southeast Asian countries accounted for 97% of all seaweed production.[57] China is the largest producer of farmed seaweed (63 percent of global production), where just one giant seaweed farm (located in Jiazhou Bay in Quingdao) claims to account for almost half of global production and is visible from space. After China, Indonesia (14 percent) and Philippines (10 percent) have been jostling for second place. Other major producers include Republic of Korea, Japan and Democratic People's Republic of Korea. Outside of Asia, Chile is the most important seaweed producer, followed by Tanzania, Mozambique and Madagascar.

Seaweed farmers traditionally stick close to the coastline, seeding long submerged strings with their desired species of seaweed and then gathering the fronds for drying and processing on land. Since the 1970s the US Marine Biomass Program has proposed the large-scale, open ocean gathering of floating Sargassum seaweeds (to be harvested for fuels). A new investment strategy proposes to develop open ocean seaweed farms using tethered nets, pens and cage-like structures. Advocates of today's "blue economy" propose to mix seaweed aquaculture with offshore wind farms – using wind structures as anchors for floating seaweed rafts.[58]

Seaweed to Biofuel

The idea of transforming seaweeds into biofuels has a long history, but little commercial success. More recently, numerous start-ups and new initiatives aim to harvest ocean weeds for fuel. For example:

- In 2007 Mitsubishi Heavy Industries proposed a large-scale project (10,000 sq. kilometers) off the coast of Japan to harvest sargassum in nets for ethanol. The initiative is reportedly supported by other industrial firms, including NEC Toshiba Space Systems, Mitsubishi Electric, IHI, Sumitomo Electric Industries, Shimizu Corporation, Toa Corporation and Kanto Natural Gas Development Co., Ltd.[59]
- US-based synthetic biology company Bio Architecture Lab (BAL) is developing Chilean seaweed farms for ethanol in collaboration with Chilean oil company, ENAP, while also making deals with Norwegian oil giant Statoil to develop a second seaweed-to-ethanol farm in Norway.[60]
- BAL also partners with chemical giant DuPont to turn seaweed to isobutanol (a more energy-rich fuel than ethanol).[61]
- A joint venture between DuPont and BP (called Butamax) aims to bring seaweed fuels to market.[62]
- In March 2011 shipping giant Stolt Nielsen bought an undisclosed stake in Norway's Seaweed Energy Solutions.[63]

Leading companies in seaweed and hydrocolloids industry

FMC Biopolymer (subsidiary of FMC Corporation, USA)
Shemberg Corporation (Philippines)
CP Kelco (subsidiary of J.M. Huber Corporation, USA)
Cargill (USA)
Danisco (owned by DuPont, USA)
Qingdao Gather Great Ocean Seaweed Industry (China)
Qingdao Bright Moon Seaweed Industry (China)
Compañía Española de Algas Marinas (Spain)
Kimica Corporation (Japan)

Source: ETC Group

Microalgae and Biofuels

In contrast to the relatively established seaweed and hydrocolloids industry, the existing industry for microalgae is...well...micro-sized. The most established microalgae markets sell food and feed supplements. However the microalgae industry is currently undergoing massive expansion due to the possibility of deriving biofuels from microalgal species. Giant fuel and chemical companies such as ExxonMobil, BP, Chevron and Dow Chemical are partnering with new algal startups to harvest the natural hydrocarbon oil produced by some algal species. New synthetic biology players such as Solazyme, Synthetic Genomics, Inc. and Joule Unlimited are betting their entire business plans on algae because it is fast growing and relatively easy to engineer. Even agbiotech companies are joining the microalgal boom.

Corporate Investors: Seaweed to Biofuel

Mitsubishi Heavy Industries (Japan)
DuPont (USA)
BP (UK)
Bio Architecture Lab (USA)
ENAP (Chile)
Statoil (Norway)
Oil Fox (Argentina)
Seaweed Energy Solutions (Norway)
Stolt Nielsen (Norway)

Source: ETC Group

In March 2011 Monsanto invested an undisclosed equity stake in algal biofuel leader Sapphire Energy.[64] Dow Chemical, which is already collaborating with algae producer Algenol, inked a major deal with Solazyme to deliver 60 million gallons of algal oil as an insulating chemical for electric transformers.[65] Solazyme has existing deals with Chevron and Unilever to provide fuels and food ingredients and with the US Navy to provide biofuel. Synthetic Genomics, Inc. snagged a high profile $600 million deal with ExxonMobil to develop microalgal biofuels.[66] In a sign of the times, the only major algae venture that focused on natural algal strains, Cellana – a partnership between HR Biopetroleum and Dutch oil giant Shell – was recently terminated by Shell.[67] That means most of the activity in algal biofuels depends on synthetic biology approaches. Interest in microalgal production is also coming from wastewater companies and industrial livestock operations that see algae as a means to clean up their waste streams while creating new value in biofuels.[68]

The Fishing and Aquaculture Sector

By far the biggest harvest of marine and aquatic biomass is captured by the fishing and aquaculture industry, and most is destined for human consumption. In 2009 145 million tonnes of fish and marine animals were caught or farmed;[69] over 80 percent of that biomass (117.8 million tonnes) was destined for human consumption. Wild-caught fish still accounts for the largest share (90 million tonnes), but the aquaculture industry (especially shrimp, salmon, catfish and tilapia) has boomed over the past 40 years growing at an average rate of 8.3 percent per annum worldwide (slowing recently to 5.3 percent growth).[70] Proponents of the blue economy suggest that the next frontier will take aquatic farming away from the coasts and inland waters to the high seas. To that end several companies are now developing and testing large, high-sea fish cages that are either tethered to the seabed or travel with the currents as fish grow from fingerlings to full size.[71]

Microalgal Biofuel Companies

Source: ETC Group

Company (Headquarters)	Corporate / Government Partners
Algenol (USA)	Dow Chemical, Linde Group
Aurora Algae (USA/Australia)	Australian government
Bio Fuel Systems (Spain)	
Cellana, Inc. (USA – formerly HR Biopetroleum)	Hawaiian Electric Co., Maui Electric Co., the National Alliance for Advanced Biofuels and Bioproducts consortium, and US Dept. of Energy
Joule Unlimited (USA)	
Martek (USA)	Acquired by DSM (Netherlands) 2011
OriginOil (USA)	Ennesys (joint venture partner – France), MBD Energy (Australia), Mexican government
PetroAlgae (USA)	Sky Airline (Chile), Haldor Topsoe (Denmark)
Phycal (USA)	SSOE Group, engineering firm
Photon8 (USA)	University of Texas at Brownsville and Texas Southmost College
Sapphire Energy (USA)	Monsanto (equity investor), Linde Group
Solazyme (USA)	Chevron, Unilever, Qantas, Bunge, Dow, US Navy
Synthetic Genomics (USA)	ExxonMobil (joint venture)
TransAlgae Ltd. (Israel)	MOU with Endicott Biofuels (USA)

Others are proposing to mix high seas fish farming with other uses, e.g. establishing seafarms around offshore wind platforms where caged fish and seaweed can be harvested along with the wind. Libertarian-minded investors see such 'seasteads' as frontiers for new capitalist societies that will run offshore banking, gambling, data warehousing or medical tourism.[72]

Seafood as Biomass

Just as the harvesting of terrestrial biomass destined for biofuel/bioenergy competes with food for people, so does the exploitation of aquatic biomass for fuel/energy. Most of the interest in aquatic biomass for fuels and chemicals focuses on plants, but there is historic precedent for using fish and other sea creatures as a source of industrial biomass. Before the advent of petroleum and kerosene, whale and fish oil were the leading source of liquid fuel for light and heat. More recently, fishmeal has been marketed for a range of uses, from feed to fertilizer. (Because oil is a by-product of fishmeal, it is used as a fuel to dry the meal during processing.) According to one aquatic biomass expert, every kilogram of fishwaste can be converted into a liter of biodiesel.[73] Several aquatic enterprises are now looking to turn fishwaste into fuel. Vietnamese catfish producer Agfish reported in 2006 on plans to build a 10,000 tonne per year (3 million gallons) factory to convert catfish to biodiesel.[74] Silicon Valley biofuel startup LiveFuels Inc. wants to harvest fish from oceanic deadzones such as the Gulf of Mexico.[75] The goal is to build cages in parts of algae blooms (caused by fertilizer run-off and other sources of pollution) and fill the cages with carp, tilapia or sardine. The caged fish will feast on excess algae and the scheme will theoretically harvest 25,000 pounds of fish per acre that can be converted into fishmeal and biofuel (a dubious but ingenious scheme for capitalizing on chemical pollution).

World's Top 10 Fishing and Aquaculture Companies

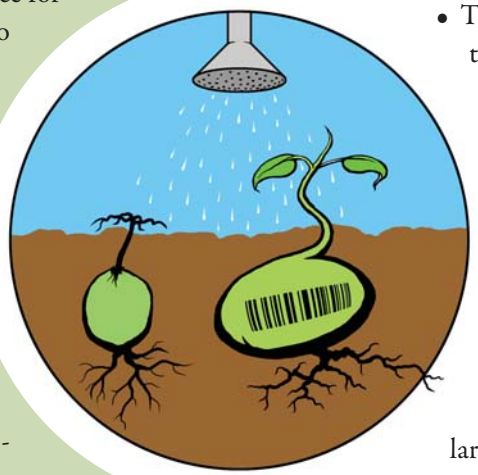
Source: OECD[76]

Company (Headquarters)	2007 Turnover (US$ million)
1. Maruha Group (Japan)	6,060
2. Nippon Suisan Kaisha (Japan)	4,593
3. Icelandic Group (Iceland)	1,520
4. Nchiro Corportion (Japan)	1,371
5. Chuo Gyorui Co. (Japan)	1,315
6. Austevoll Seafood (Norway)	1,305
7. Kyokuyo (Japan)	1,288
8. Marine Harvest (Norway)	840
9. Connor Bros. Income Fund (Canada)	809
10. Cermaq ASA (Norway)	791

Seeds and Pesticides

Seeds and Pesticides and the Bioeconomy

Commercial seeds, the first link in the agro-industrial food chain, are the starting place for crop-based feedstocks that will be used to produce not just food, feed and fibre, but also energy, high-value chemical and consumer products (e.g., plastics, pharmaceutcals). Major seed/pesticide enterprises are already hopping on the bioeconomy bandwagon. Monsanto, Dow and DuPont are among those partnering with companies to develop new technology platforms to manufacture bio-based agro-industrial products.



World's Top 10 Seed Companies

Source: ETC Group (reporting currencies converted to US$ using historical exchange rates)

Company (Headquarters)	Seed Sales 2009 (US$ million)	Market Share
1. Monsanto (USA)	7,297	27%
2. DuPont (Pioneer) (USA)	4,641	17%
3. Syngenta (Switzerland)	2,564	9%
4. Groupe Limagrain (France)	1,252	5%
5. Land O' Lakes/Winfield Solutions (USA)	1,100	4%
6. KWS AG (Germany)	997	4%
7. Bayer CropScience (Germany)	700	3%
8. Dow AgroSciences (USA)	635	2%
9. Sakata (Japan)	491	2%
10. DLF-Trifolium A/S (Denmark)	385	1%
Total Top 10	**20,062**	**73%**

Key facts:

- The global commercial seed market in 2009 is estimated at $27,400 million.
- The top 10 companies account for 73% of the global market (up from 67% in 2007).
- Just 3 companies control more than half (53%) of the global commercial market for seed.
- Monsanto, the world's largest seed company and fourth largest pesticide company, now controls more than one-quarter (27%) of the commercial seed market.
- Dow Agrosciences – the world's fifth largest pesticide company – made a dramatic re-entry on the top 10 seed company list in 2009 following a seed company-buying spree that included Hyland Seeds (Canada), MTI (Austria), Pfister Seeds (USA) and Triumph Seed (USA), among others.

The commercial seed sector is inextricably linked to the agrochemical market. Five of the top 6 agrochemical companies also appear on the list of the world's biggest seed companies, and the one that doesn't – BASF – has significant partnerships with the biggest players in seeds. BASF's long-term collaborations involve every major crop and include a project with Bayer CropScience to develop high-yielding hybrid rice varieties and a $2.5 billion R&D deal with Monsanto on stress-tolerance and yield in maize, cotton, canola, soybeans and wheat.

Technology Providers

Industry analyst Context Network describes the seed sector as having evolved "from a production/niche product marketplace to a technology distribution marketplace."[77] In other words, seeds are now like our cell phones and laptops – containers that deliver proprietary technologies. Up till now, those technologies have been variations on just two types of genetically engineered traits: one that tolerates the application of an herbicide (for weed control) and another trait that resists certain pests.

For the Gene Giants, climate change and the push to develop energy crops/feedstocks to fuel the bio-based economy offer irresistible market opportunities. Biotech's newest generation of proprietary seed traits focus on so-called climate-ready genes and GM traits that aim to maximize plant biomass.

Climate Changing Business Plans

In 2008 ETC Group released its first report on Big Ag's efforts to monopolize genetically engineered, "climate ready" traits intended to withstand environmental (i.e., abiotic) stresses associated with climate change, such as drought, heat, cold, floods, saline soils, etc. Between June 2008 and June 2010, the Gene Giants and their biotech partners submitted at least 261 "inventions" related to climate-ready crops to patent offices around the world seeking monopoly protection.[78] Just six corporations (DuPont, BASF, Monsanto, Syngenta, Bayer and Dow) and their biotech partners control 77% of the 261 patent families (both issued patents and applications).

The commercial seed sector is inextricably linked to the agrochemical market. Five of the top 6 agrochemical companies also appear on the list of the world's biggest seed companies.

In January 2011, *Agrow World Crop Protection News* published a review of recent patenting activity at the US Patent & Trademark Office (USPTO) related to plant biotechnology (March–December 2010).[79] Their findings support ETC Group's conclusions: environmental stress tolerance and feedstock/bioenergy traits are the priority focus for biotech R&D (see chart below).

The most active patenting area, by far, is abiotic stress tolerance. Just 15 applications related to herbicide tolerance were submitted, for example, compared to 132 applications related to abiotic stress tolerance in plants. Just 4 Gene Giants and their biotech partners account for at least two-thirds (66%) of the patent applications related to climate ready crops. Energy crops or biomass/feedstock traits (i.e., altered lignin content and altered oil or fatty acid content) came in second with 68 applications.

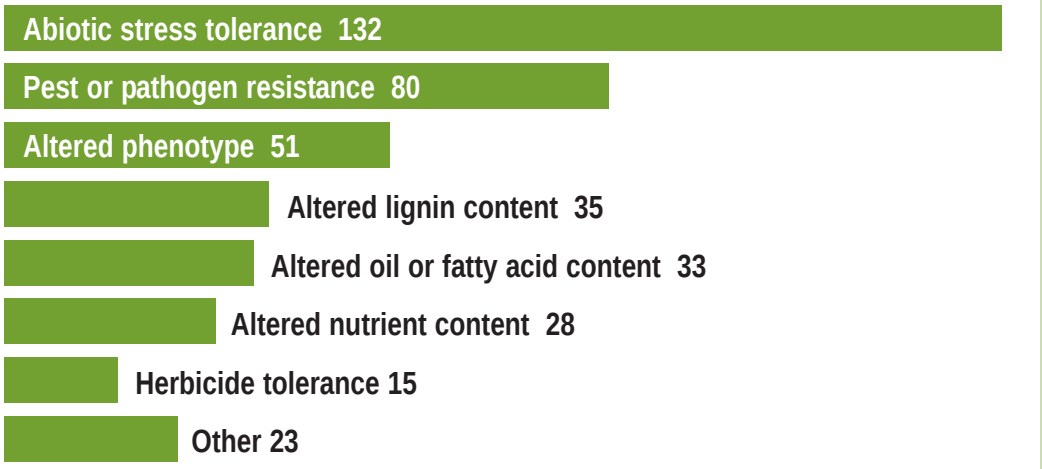
Consolidation and Emerging Markets

The seed industry consolidation trend continues, with emerging markets – especially Africa – the most recent target. In 2010, Pioneer (DuPont) announced it intended to make its largest acquisition ever by buying South Africa's biggest seed company, Pannar Seed. Pioneer's purchase would have doubled its seed sales in Africa, giving it access to local germplasm as well as a foothold in 18 other countries on the continent where Pannar does business.[80] Under pressure from activists – led by the African Centre for Biosafety and Biowatch – South Africa's Competition Tribunal nixed the deal in December 2010. Pioneer is appealing, contending that the Tribunal's decision is based on unfounded prejudices against GMOs and multinationals.[81] The Tribunal will hear Pioneer's appeal in September/October 2011. The African Centre for Biosafety has pledged to keep fighting the deal and has launched an investigation into all seed holdings and licensing/cross-licensing deals in South Africa of DuPont's biggest rival, Monsanto. (Monsanto is South Africa's second biggest seed player;[82] its engineered traits are present in an estimated 75% of all GM maize planted in South Africa.[83])

As this report was in press, South Africa's Competition Tribunal announced its decision to uphold the prohibition on Pioneer's acquisition of Pannar Seed.

Biotech Plant Patent Applications, USPTO (March - December 2010)

Source: *Agrow World Crop Protection News*



Greener (GM) Pastures?

The United States Government and Biotech's Revolving Door

Name	Current US Goverment Job	Old Job
Roger N. Beachy	Former Director (as of May 2011) National Institute of Food and Agriculture, largest public funder of ag research awards. Appropriated $1.2 billion in funding in 2009.	Former president of the non-profit Danforth Plant Science Center, founded with $50 million gift from Monsanto
Rajiv Shah	Director, US Agency for International Development	Former agricultural programs director, the Bill & Melinda Gates Foundation; board member, Alliance for Green Revolution in Africa (AGRA)
Islam A. Siddiqui	Chief Agriculture Negotiator, Office of US Trade Representative	Former vice-president, CropLife America, pesticide/biotech lobby group
Ramona Romero	General Counsel of the United States Department of Agriculture (USDA)	Corporate Counsel at DuPont

Battle of the Bullies

Meanwhile, back at HQ (USA), Monsanto and DuPont are slugging it out in court. Monsanto filed a lawsuit against DuPont in May 2009, alleging patent infringement for field-testing corn and soybeans with "stacked" traits (two or more engineered traits) involving Monsanto's herbicide-tolerant trait (which DuPont has been licensing from Monsanto since 2002) combined with its own herbicide-tolerant trait. DuPont fought back, suing Monsanto one month later for violating antitrust laws. The battle continues amid a US Department of Justice (DOJ) investigation into anti-competitive practices in agriculture. It remains to be seen whether the DOJ's investigation will result in any legal action to rein in the Gene Giant's oligopoly. Judging from the high-ranking biotech boosters in the Obama administration (see box), it's not easy to be hopeful on the anti-trust front.

Under fire at home and abroad, Monsanto is now downplaying its dominance in the world seed market. Brad Mitchell, Monsanto's Director of Public Affairs, told Organic Lifestyle Magazine in late 2009, "Monsanto's share of the total worldwide seed market is very small. Of the global seed market, it is estimated that greater than 80 percent is 'open source' farmer saved seed.

So, the commercial seed market is less than 20 percent and Monsanto's is a fraction of that 20 percent."[84] Never mind that Monsanto and its top-ranking rivals spent the last 15 years attempting to wipe-out competition from seed-saving farmers – via lawsuits, monopoly patents and the development of genetic seed sterilization technologies (a.k.a. Terminator). For Monsanto and seed industry giants, the target markets are precisely those areas of the global South where farming communities are self-provisioning in seeds and where the largest remaining stocks of biomass are found.

Meanwhile, DuPont – the world's 2nd largest seed firm – paints a very different picture of Monsanto's market dominance in seeds. In comments submitted to US antitrust investigators, DuPont points to Monsanto's monopoly in GM trait markets for herbicide-tolerant soybean (98 percent) and corn (79 percent). DuPont also notes that Monsanto, as "a single gatekeeper," has the power to raise seed prices and exclude competition.[85] DuPont sees a clear need for at least one more corporate gatekeeper!

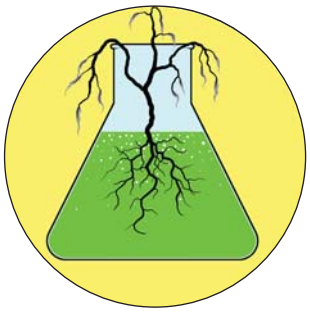
Monsanto Scientists Collaborate with Company Patent Attorneys to Develop Perfect Timing?

Monsanto's patent on the herbicide glyphosate (Roundup) expired in 2000, the same year the first known Roundup-resistant weed cropped up – a species of horseweed growing in a Delaware, USA field of Roundup Ready soybeans.[86] A decade later, more than 130 types of "herbicide tolerant" weeds are growing in an estimated 11 million acres in the United States – the motherland of Roundup Ready soy. The Roundup Ready weeds are taking root worldwide,[87] but according to Dave Mortensen, professor of weed and applied plant ecology at Penn State University, "Most of the public doesn't know because the industry is calling the shots on how this should be spun."[88]

Much has been made of Monsanto's recent "concession" – amid a US Department of Justice investigation into anti-competitive practices in agriculture – to allow farmers to save Roundup Ready soybeans from harvest once the patent on the engineered trait expires in 2014.[89] Monsanto's magnanimity is disingenuous because the company won't have a legal right to enforce the patent, and, besides, Roundup Ready ain't what it used to be.

Monsanto, of course, blames farmers for the emergence of superweeds – for failing to rotate crops and for applying Roundup exclusively ("It comes down to basic farm management," according to the company's head of global weed resistance management).[90] Monsanto and the other Gene Giants are scrambling to develop second-generation GM crops that are tolerant to two or more herbicides – including more toxic and environmentally hazardous ones – such as 2,4-D, a component of the Vietnam War defoliant, Agent Orange, and dicamba, which is chemically-related to 2,4-D.[91] Monsanto plans to "stack" its glyphosate-tolerant gene with a dicamba-tolerant gene in soybeans, and in 2010 began the US regulatory approval process. So just when herbicide resistant weeds render Monsanto's Roundup completely useless for weed control – around the same time the company's Roundup Ready trait goes off-patent – Monsanto plans to have its next proprietary techno fix for weed control waiting in the wings.

World's Top 10 Agrochemical Companies



Sources: ETC Group (reporting currencies converted to US$ using historical exchange rates)

Rank / Company (Headquarters)	Agrochemical Sales, 2009 (US$ million)	Market Share
1. Syngenta (Switzerland)	8,491	19%
2. Bayer CropScience (Germany)	7,544	17%
3. BASF (Germany)	5,007	11%
4. Monsanto (USA)	4,427	10%
5. Dow AgroSciences (USA)	3,902	9%
6. DuPont (USA)	2,403	5%
7. Sumitomo Chemical (Japan)	2,374	5%
8. Nufarm (Australia)	2,082	5%
9. Makhteshim-Agan Industries (Israel)	2,042	5%
10. Arysta LifeScience (Japan)	1,196	3%
Total Top 10	**39,468**	**89%**

The world market for agricultural chemicals in 2009 is estimated at $44,000 million.

- In 2009, the global market share of the Top 10 pesticide companies topped 90% for the first time.
- The top 6 companies, all of them sellers of proprietary (i.e., patented) pesticides, account for over 72% of the agrochemical market. Those very same companies also play starring roles in the World's Top 10 Seed Companies.
- The off-patent pesticide companies (nos. 7-10) are shaking up the bottom half of the league table. Nufarm nudged ahead of Makhteshim-Agan in 2009; however, in June 2010 Makhteshim-Agan announced it would acquire Albaugh, the largest off-patent pesticide firm in the Americas (with close to one billion dollars in sales in 2009).

Chemically-Challenged

When the sales numbers came in for 2008, pesticide execs popped open the bubbly. The next year's tally had them popping mood elevators: global pesticide sales declined by 6.5% in 2009 from 2008.[92] Though the sector's slide seems to be staunched for now, sales in 2010 were still below 2008 levels. Industry analysts point to artificially high prices for herbicides in 2008 and overcapacity production of glyphosate (generic Roundup) as the main culprits in the sector's sudden downturn. Depressed currencies didn't help. And, finally, analysts suggest, increased adoption of herbicide-tolerant GM crops contributed to lower pesticide use. Recent studies,[93] however, show the opposite is true: planting genetically-engineered, herbicide-tolerant crops increases herbicide use due to the emergence of herbicide-resistant weeds (requiring more frequent applications, higher doses and/or additional active ingredients).

While global sales of pesticides were down in 2009 and 2010, the good news (for companies) / bad news (for the environment and human health) is that pesticide use in the developing world is rising dramatically. Bangladesh, for example, increased its use of pesticides by an astonishing 328% over the last 10 years.[94] Between 2004 and 2009, Africa and the Mideast, as a region, posted the biggest increase in pesticide use. Central and South America are expected to experience the biggest increase in pesticide use to 2014, when the world market for pesticides may reach $52 billion, according to The Freedonia Group.[95] Production of agrochemicals in China – mostly production of those formulas that have already gone off-patent – reached more than 2 million tonnes at the end of November 2009, more than double 2005's production.[96]

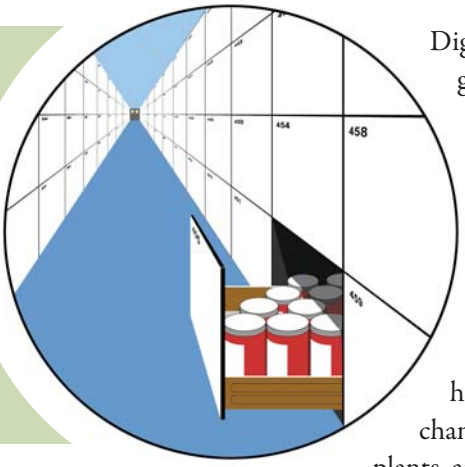
Weed Killing Greenwash

Monsanto has long touted the benefits of its GM herbicide tolerant crops, not just for weed control, but also as a climate-friendly technology that reduces greenhouse gas emissions.[97] Roundup Ready crops promote chemical-intensive weed control and thus minimal plowing of land – a practice known as chemical "no-till," or "conservation tillage." According to Monsanto, "no-till practices in 2005 reduced carbon dioxide releases from agriculture by an amount equal to the emissions from about four million cars."[98] In the United States, farmers who practice chemical no-till briefly benefited from carbon credit trading schemes through the Chicago Climate Exchange – a voluntary carbon reduction and offset trading platform. (The Exchange was closed in November 2010 due to lack of political support for carbon trading in USA). If Monsanto and other Gene Giants get their way, chemical no-till farming practices will become eligible for carbon offsets under the UN climate treaty's Clean Development Mechanism – a convenient way to boost the company's bottom line.[99] But recent scientific studies reject the view that no-till farming results in significant accumulations of carbon in the soil.[100] An extensive review of the literature by USDA and Minnesota soil scientists in 2006 concluded that evidence of no-till's promotion of carbon sequestration "is not compelling."[101] More recent studies confirm that no-till practices sequester no more carbon than plowed fields.[102] There's no question that farmers have enormous capacity to sequester carbon by managing and building soil organic content using biological practices in integrated farming systems. But chemical no-till is a false solution to climate change. Monsanto's hard-sell on no-till rides on the coattails of traditional conservation tillage practices and hijacks the concept developed by many farming communities worldwide.

Plant Gene Banks

Bioeconomy and *Ex Situ* Plant Germplasm

The bioeconomy is driving heightened interest in plant germplasm as the source of genes and traits that can be exploited to produce high-yielding feedstocks for the production of food, fuel, energy, chemicals, pharmaceuticals, etc.



This section examines the control of global storehouses of *ex situ* plant germplasm – mostly in the form of seeds – found in the world's gene banks. The evolution of synthetic biology, genomics and off-the-shelf chemical synthesis of DNA could profoundly alter current practices related to biodiversity conservation and access to germplasm. Rather than sourcing genes from nature or gene bank samples, scientists will be able to download digital DNA sequences or genome maps that can be rapidly constructed by commercial DNA "foundries." Mail-order genes and gene sequences are now common. Within a decade, it may become routine to specify the genome of a complex organism in an online order form and receive it via mail a few days later – allowing researchers to circumvent access and benefit-sharing agreements and biopiracy prohibitions.

Digital DNA makes it possible to download genomes off the Internet onto laptops, enabling scientists to create and re-design living organisms with synthetic DNA.

In coming decades, millions of people whose food and livelihood security depends on farming, fishing, forests and livestock-keeping will face climatic conditions without precedent in the history of agriculture. The rate of climate change is likely to exceed the capacity of many plants, animals, fish and microbes to adapt. The genetic diversity of plants and animals and the diverse knowledge and practices of farming communities are the two most important resources for adapting agriculture to local environmental conditions. Farmers' access to and exchange of germplasm, both *in situ* and *ex situ*, is paramount.

However, much of the diversity we need to prepare for tomorrow is not stored in gene banks today – especially wild crop relatives and underutilized crop species, including thousands of crops and species that are consumed and traded locally but do not enter the world trading system. By one estimate, well over 90% of useful genetic variability may still be in the wild.[103]

Privatising Jatropha Germplasm

Jatropha *(Jatropha curcas)* is a low-growing tree, native to Central and South America that grows throughout Africa, Asia and Central America. It is frequently hyped as the South's "cinderella" bioenergy crop because it is drought- and pest-tolerant, grows well on so-called "marginal land" and its seeds yield 30-35% oil that bioenergy companies are transforming into alternatives for the diesel, petrochemical and jet fuel industries. Agbiotech and syn bio companies are eagerly collecting (and privatising) Jatropha germplasm with the goal of developing elite, high-yielding Jatropha hybrids for large-scale commercial production. For example, California-based SG Biofuels, Inc. boasts that it has "developed and curated the world's largest and most diverse collection of Jatropha germplasm, including more than 7,000 accessions of Jatropha collected from the center of origin of the species, Central America."[104]

The company's germplasm library holds more than 12,000 unique genotypes and estimates that it holds "5 times the genetic diversity observed in a collection of Jatropha from India, Africa, and Asia."[105] In 2010, California-based synthetic biology company Life Technologies Corporation and SG Biofuels announced they had completed sequencing the *Jatropha curcas* genome.[106] In mid-2011, SG Biofuels reported that, in addition to signed contracts for the cultivation of the company's Jatropha hybrids on 250,000 acres (101,000 ha), the company has plans for more than 1 million acres (~405,000 ha) of Jatropha projects worldwide.[107] SG Biofuels has already filed nine provisional patents for traits that the company claims will have a direct impact on yield and profitability of Jatropha.

The world's largest collections of *ex situ* crop germplasm are held by international gene banks and national governments. Largely due to decades-long campaigns by civil society, farmers and social movements, the crop germplasm held in international gene bank collections is largely off-limits to intellectual property claims. To insure farmers' access to germplasm, restrictive policies (i.e., seed laws, intellectual property regimes, contracts and trade agreements) that create barriers to farm-based plant breeding, seed-saving and exchange must be eliminated.

World's Biggest Gene Banks (national and international)

Top 20 ranked by number of Accessions, 2008

Status	Country / Name	Number of accessions	% world total
Nat.	**USA**	508,994	6.9
Nat.	**China**	391,919	5.3
Nat.	**India**	366,333	5.0
Nat.	**Russia**	322,238	4.4
Nat.	**Japan**	243,463	3.3
Int'l	**CIMMYT**	173,571	2.3
Nat.	**Germany**	148,128	2.0
Int'l	**ICARDA**	132,793	1.8
Int'l	**ICRISAT**	118,882	1.6
Int'l	**IRRI**	109,161	1.5
Nat.	**Brazil**	107,246	1.4
Nat.	**Canada**	106,280	1.4
Nat.	**Ethiopia**	67,554	0.9
Int'l	**CIAT**	64,446	0.9
Int'l	**AVRDC**	56,522	0.8
Nat.	**Turkey**	54,523	0.7
Int'l	**IITA**	27,596	0.4
Int'l	**WARDA**	21,527	0.3
Int'l	**ILRI**	18,763	0.3
Int'l	**CIP**	15,043	0.2
Total		**3,054,982**	**41.3**

Source: FAO, *The Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*, 2010 [108]

According to FAO's *Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture*:

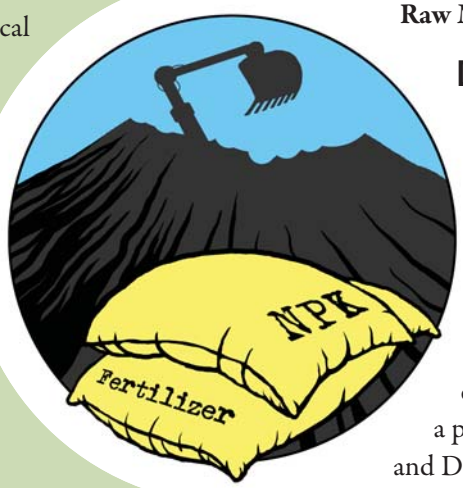
- The total number of accessions of plant germplasm conserved *ex situ* worldwide has increased by approximately 20 percent (1.4 million) since 1996, reaching 7.4 million.
- FAO points out that the number of accessions does not necessarily mean more diversity. Of the total 7.4 million accessions, less than 30% are believed to be distinct accessions (1.9-2.2 million).
- National government gene banks conserve about 6.6 million accessions, 45 percent of which are held in only seven countries, down from 12 countries in 1996. (International gene banks refer to germplasm collections managed by eleven of the Consultative Group on International Agricultural Research (CGIAR) centres on behalf of the world community.[109])
- Although international gene banks account for only 24% of the total number of *ex situ* accessions, their collections are better characterized and evaluated, and are believed to contain a greater number of distinct accessions. From 1996-2007, the CGIAR gene banks distributed more than 1.1 million samples; nearly half the germplasm was distributed within or between the CGIAR centres, and 30 percent went to national agricultural researchers (NARS) in the global South. OECD country NARS received 15 percent and the private sector accounted for 3 percent.
- The nature of the accessions (for example, whether they comprise advanced cultivars, breeding lines, farmers' varieties or landraces, wild relatives, etc.) is known for about half of the material conserved *ex situ*. Of these, about 17 percent are categorized as advanced cultivars, 22% breeding lines, 44% landraces and 17% wild or weedy species.
- Neglected and underutilized crop species and crop wild relatives are generally under-represented in *ex situ* collections. One study predicts that 16-22% of wild relatives of species with direct value to agriculture may be in danger of extinction due to climate change.[110] Crop wild relatives have contributed millions of dollars to agriculture. For example, commercial-scale cultivation of sugar cane, tomatoes and tobacco would not be possible without the disease-resistance genes contributed by wild relatives of these crops.[111] Traits from wild sunflowers are worth an estimated $267-$384 million annually to the sunflower industry in the United States; three wild peanuts have provided resistance to the root knot nematode, a pest that cost peanut growers worldwide $100 million *per annum*.[112]

Fertilizer and Mining Industries

Mined Fertilizers and the Bioeconomy

Mined fertilizers are a strategic, geopolitical resource – and a controversial one. They play a critical role in farming and global food security. With skyrocketing demand for high-yielding plant biomass, potash, phosphorus and nitrogen – the three macro-nutrients in chemical fertilizers – are hot commodities. According to industry statistics, almost half of the world's population lives on food produced with nitrogen fertilizers.[113]

The top 10 mining corporations account for an estimated 32% of the world mining market, according to the Raw Materials Group



Digging for Profits

According to Datamonitor, the global fertilizer market withered by an astounding 37% in 2009 to reach a value of $90,183 million. "We believe 2009 was an aberration in fertilizer history," says PotashCorp's 2009 annual report, in an attempt to make sense of the decline in global sales of all fertilizers from a peak in 2007. The sector is on the rebound and Datamonitor predicts the fertilizer market will be worth an estimated $142,869 million by 2014 (an increase of 65% from 2009).

World's Top 10 Fertilizer Companies

Source: PotashCorp 2009 Annual Report

Rank / Company (Headquarters)	Sales, 2009 US$ Millions
1. Yara International (Norway)	10,843
2. The Mosaic Company (USA)	10,298
3. Agrium Inc. (Canada)	9100
4. K+S Group (Germany)	4925
5. Israel Chemicals Ltd. (Israel)	4554
6. CF Industries, Inc. (USA) pro forma (+ Terra, USA)	4189
7. PotashCorp (Canada)	(TBC) 4189
8. JSC Uralkali (Russia)	1178
9. Arab Potash Company Ltd. (Jordan)	552
10. Sociedad Quimica y Minera de Chile S.A.	338

World's Top 10 Mining Companies

Source: Raw Materials Group, Stockholm, 2010

Rank / Company (Headquarters)	Market share - mined production of all minerals (%) 2009	Fertilizer assets?
1. Vale SA (Brazil)	5.5%	Yes
2. BHP Billiton Group (Australia)	5.0%	Yes
3. Rio Tinto (UK)	4.9%	Sold – seeking new assets
4. Anglo American (UK)	3.0%	Yes
5. Freeport-McMoran Copper & Gold Corp. (USA)	2.9%	Sold
6. Barrick Gold Corp. (Canada)	2.4%	No
7. Corporación Nacional del Cobre (Chile)	2.4%	No
8. Xstrata plc (Switzerland)	2.1%	No
9. Norilsk Nickel Mining & Metallurgical Company (Russia)	1.9%	No
10. Newmont Mining Corp. (USA)	1.8%	No

As the raw material resource grab intensifies, the fertilizer industry is undergoing rapid consolidation. In recent years, the biggest catalyst for consolidation comes from the world's major mining companies. It's logical that mining companies – which already have the tools and technology to extract in-the-ground resources – would be scooping up fertilizer assets. As *The Economist* put it, "feeding the world has become a mouth-watering opportunity" for corporate mining interests.[114] Amid soaring food prices, companies are jockeying for position to have their shovels digging in the right rock at the right time to make the most profit.

The fertilizer industry worldwide is seeing fervent M&A activity. In the words of Yara's CEO, Joergen Ole Haslestad, "Consolidation of the fertilizer industry worldwide is far from over."[115] Recent deals include:

- In January 2011, Cargill announced a $24.3 billion deal to spin-off its 64% stake in the **Mosaic Company** – one of the world's largest phosphate and potash sellers.
- In 2010, the world's second largest mining corporation, Australia's **BHP Billiton Ltd**., made a stunning $39 billion hostile bid to takeover the world's largest fertilizer maker, Canadian-based **Potash Corporation**. The Canadian government ultimately vetoed the deal because the federal election was imminent and Saskatchewan votes (the province where Potash is located) were critical for the ruling minority party.
- **BHP Billiton Ltd**. acquired Canada's Athabasca Potash Inc. in 2010 for $331 million.
- In February 2011, shareholders for Russian fertilizer producers **Uralkali** and **Silvinit** approved a merger worth $1.4 billion, which would create the world's third largest potash company. Rival fertilizer firm Akron, which owns 8% of Silvinit's voting shares, filed a lawsuit to stop the deal.
- In May 2010, Brazil's **Vale SA**, the world's leading miner of iron ore, bought Bunge Ltd.'s fertilizer assets in Brazil for $3.8 billion (including a 42.3% interest in Fertilizantes Fosfatados, Brazil's largest supplier of fertilizer ingredients and Bunge's Brazilian phosphate mines and production facilities). In March 2011, Vale announced it would sell up to 49% of its fertilizer unit (retaining a controlling interest) in an IPO sometime before the end of 2011.
- In April 2010, **CF Industries** (USA) scooped up **Terra Industries** for $4.6 billion, while fending off a hostile takeover by Agrium.
- **Rio Tinto**, the world's third largest mining company, sold its potash assets to **Vale** for quick cash in 2009, but CEO Tom Albanese reports: "I have said to our geologists, 'I still like potash, find me some more.'"[116]
- In 2010, due to soaring internal demand for raw materials, the Chinese government spent $8 billion acquiring domestic mining and metal interests. The Chinese government aims to build a mining conglomerate that will have a "global impact unrivalled by any other sector in State-owned enterprise" according to industry analysts.[117]

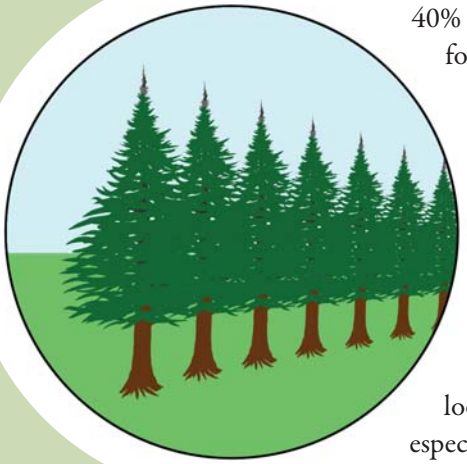
Peak Phosphorus...or not?

As a non-renewable resource critical to plant growth, phosphorus – and how much of it is left on earth – is a critical issue. In our 2008 report, ETC Group cited the Global Phosphorus Research Initiative's (GPRI) estimate that reserves of phosphate will likely be depleted within the next 50-100 years. Global phosphorus reserves concentrated in a handful of countries (Morocco, Western Sahara and China) account for some 60% of world reserves, with smaller deposits in the United States, South Africa and Jordan; trade is dominated by just 3 firms: Mosaic, Potash Corp. and OCP[118] (Morocco's state-controlled monopoly).[119] In September 2010, forecasts for global phosphorus supplies were suddenly turned upside down when a new report by the International Fertilizer Development Center (IFDC), *World Phosphate Rock Reserves and Resources*, concluded that "phosphate rock concentrate reserves to produce fertilizer will be available for the next 300-400 years."[120] In January 2011, the US Geological Survey followed suit, quadrupling its revised estimate of global phosphorus reserves.[121] In its response to the IFDC report, researchers at the Global Phosphorus Research Initiative (GPRI) write that the "IFDC report should be interpreted with great caution"... and that the "IFDC phosphate rock reserve figures are still estimates based on secondary sources and shrouded in much uncertainty."[122] Finally, GPRI points out that the report's lead scientist, Steven Van Kauwenbergh, did not provide a calculation from which he derived the estimate that reserves will be available for the next 300-400 years. Unresolved questions about the estimated size and location of the planet's finite phosphorus reserves are critical issues for global food security.

Forestry and Paper

Forests and the Bioeconomy

Forest-based biomass covers 9% of the Earth's surface area. Globally, forests contain just over 600,000 million tonnes of biomass.[123] The global South accounts for 68% of the world's forest biomass (South & Central America - 36%; Africa - 20%; Asia -12%.).[124] According to FAO, an estimated 80% of the world's forests are publicly owned and managed, but private sector control is on the rise.[125]



The top 10 forestry/paper companies account for 40% of the industry's $318 billion commercial forest market.

The world's biggest forestry/paper companies represent the Old Guard BioMassters, with 7 of the Top 10 tracing their corporate roots at least as far back as the 19th century (Metsäliitto, Mondi Group and Nippon Paper Group are the 20th century latecomers). But that doesn't mean the forest giants aren't looking for new ways to increase profits, especially in the wake of a global recession that saw demand for building materials plummet. However, in a back-to-the-future move, forest companies are now selling wood and wood by-products to help meet "renewable-energy targets" in the EU. For example, wood pellets (mostly from sawdust), which are less than 10 mm in diameter, are burned in residential burners, biomass power plants and co-fired with coal. According to management consultant and engineering company, Finland-based Pöyry, 870 production plants around the globe meet current demand of 16 million tonnes.[126] Europe accounts for more than half of that demand, but markets in Asia – particularly Korea – are growing. Canada has exported wood pellets to Europe for the past ten years; the United States began exporting pellets to Europe in 2008. Together, the two North American countries have doubled their exports to Europe in two years (2009-2010).[127]

As demand grows, 2012 could see wood pellets becoming a publicly-traded commodity, like soybeans and gold. The APX-Endex energy exchange based in the Netherlands (whose ports greet most of Europe's wood pellet imports) plans to launch the trade group with 8 to 10 members.[128] An industry working group within the EU's Industrial Wood Pellet Buyers trade group (i.e., energy companies) is developing "sustainability criteria." A scan of member-affiliations makes clear who has the biggest stake in the wood pellet market: RWE (Germany), Drax Power (UK), DONG Energy (Denmark), GDF Suez and (France) and Electrabel (Netherlands).

World's Top 10 Forestry Companies

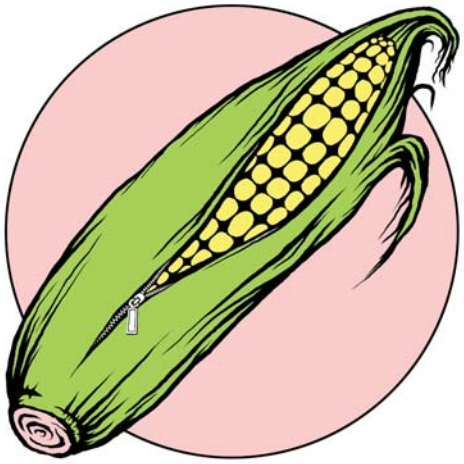
Source: Pricewaterhouse Coopers

Company (Headquarters)	Revenue 2009 (US$ million)	Share of Global Sales
1. International Paper (USA)	23,366	7.3%
2. Kimberly-Clark (USA)	19,115	6.0%
3. Svenska Cellulosa (Sweden)	14,633	4.6%
4. Oji Paper (Japan)	13,535	4.2%
5. Nippon Paper Group (Japan)	12,692	3.9%
6. Stora Enso (Finland)	12,478	3.9%
7. UPM-Kymmene (Finland)	10,768	3.3%
8. Smurfit Kappa (Ireland)	8,450	2.6%
9. Mondi Group (UK/South Africa)	7,334	2.3%
10. Metsalitto (Finland)	6,748	2.1%
Total Revenues of Top 10 Companies	**129,119**	
2009 Total Global Revenues	317,770	40.2%

Oilseed, Grain and Sugar Processors and Traders

Grain Traders and the Bioeconomy

The world's top 11 oilseed, grain and sugar processors are titans in the agro-industrial food chain, and they're not newcomers to the bioeconomy. Many of these companies have been buying, processing and selling biomass for decades (in the case of Dreyfus, Cargill and ADM, for more than a century). Just three giant enterprises, US-based grain traders/processors, Cargill, ADM and Bunge, handle the majority of grain that moves between nations.[129]



World's Top 11 Oilseed, Grain and Sugar Processors / Traders

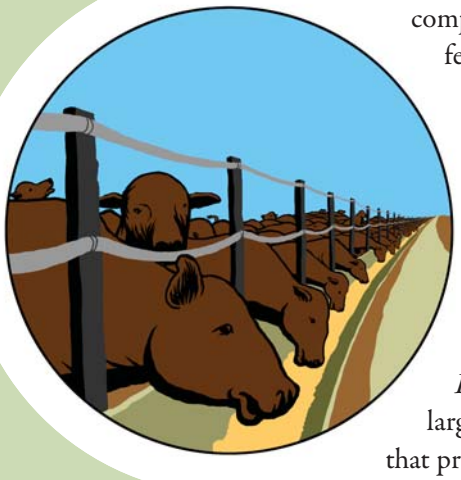
Source: ETC Group

Company (Headquarters)	Revenue 2009 (US$ million)
1. Cargill (USA)	116,600
2. ADM (USA)	69,207
3. Bunge Ltd. (USA)	41,926
4. Marubeni (Japan)	39,839
5. Itochu Intl. (Japan)	34,191
6. Louis Dreyfus Commodities (France) (Includes Santelisa Vale)	34,000
7. The Noble Group (China)	31,183
8. China National Cereals, Oils, & Foodstuffs (China)	26,445
9. Wilmar International Ltd (Singapore) (Includes Sucrogen Limited)	23,885
10. British Foods (UK) (Includes Azucarera Ebro)	15,354
11. ConAgra Foods (USA)	13,808
Total Sales of Top 11 Companies	**446,438**

Industrial Animal Feed Producers

Industrial Livestock and the Bioeconomy

The role of industrial livestock – what these animals consume, who controls them and the inputs used to produce them (feed, pharmaceuticals, livestock genetics) – affects food security, climate change, human health and the bioeconomy on a massive scale. By one estimate, livestock and their byproducts account for a staggering 32.6 billion tonnes of carbon dioxide per year, or 51 percent of annual worldwide GHG emissions.[130] At least one-third of the world's arable cropland grows feed for livestock. If those grains were devoted to feeding people instead of animals, it would meet the annual calorie needs of more than 3.5 billion people.[131] It takes 2500 litres of water to produce one industrial-raised hamburger.[132]



The giant companies that process and market compound animal feeds (that is, commercial feedstuffs containing a mixture of grains such as soybean meal, maize, sorghum, oats, barley and additives such as vitamins, minerals, antibiotics, etc).

The top 10 industrial animal feed companies account for an estimated 52% of the global animal feed market by volume.

Feed International monitors the world's 56 largest feed manufacturers – those companies that produced more than 1 million tonnes of compound animal feeds in 2009.[133] (Compound animal feeds refer to commercial feedstuffs containing a mixture of grains such as soybean meal, maize, sorghum, oats, barley and additives such as vitamins, minerals, antibiotics, etc.) Based on *Feed International*'s figures, the top 10 industrial animal feed companies account for an estimated 52% of the global animal feed market by volume. The top 3 firms account for one-quarter (24.6%). In August 2011 the world's second largest animal feed giant, Cargill, announced it will acquire Dutch animal nutrition company, Provimi, for $2.1 billion.

Perhaps more globalised than any other top-10 sector—the companies that buy and sell animal feed reflect seismic demographic shifts in livestock production, soaring demand for meat/farmed fish and the colossal market power of emerging markets. The world's largest feed-producing conglomerate is CPF of Thailand, which is expanding in Russia, parts of Africa and India. Three of the top 10 animal feed companies are based in China. Brazil is home to the world's sixth largest firm.

Top 10 Industrial Feed Producers

Source: Feed International, 2010

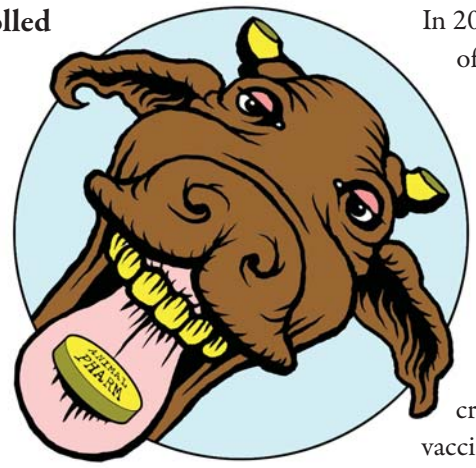
Ranked by Volume, 2009

Company (Headquarters)	Volume 2009 (million tonnes)
1. Charoen Pokphand Foods PCL (Thailand)	23.2
2. Cargill (US)	15.9
3. New Hope Group (China)	13.0
4. Land O' Lakes Purina (USA)	10.1
5. Tyson Foods (USA	10.0
6. Brasil Foods (Brazil)	9.9
7. Nutreco (Netherlands)	8.7
8. Zen-noh Cooperative (Japan)	7.5
9. East Hope Group (China)	6.5
10. Hunan Tangrenshan Group (China)	4.9

Animal Pharmaceutical Industry

In 2009, the top 10 companies controlled 76% of the animal pharmaceutical industry's global sales ($14,021 million).

In 2009, the worldwide animal pharmaceutical industry had sales of $18,500 million (excluding nutritional feed additives). In 2008, 4 livestock species (cattle, pigs, poultry, sheep) accounted for 57% of the animal health market by species; companion animals (i.e., pets) accounted for 43% of the sector's market.[134]



In 2009, the top 10 companies controlled 76% of the animal pharmaceutical industry's global sales ($14,021 million). The top 3 companies accounted for 43%. *But the 2009 figures do not reflect the most recent consolidation trends.*

In March 2010, Sanofi-aventis (owner of Merial) and Merck & Co., Inc. (owner of Intervet/Schering-Plough) announced they would join forces to create the largest seller of animal drugs and vaccines in the world – overtaking number one ranking Pfizer.[135] The new joint venture is equally owned by Merck and Sanofi-aventis.

Top 10 Animal Pharmaceutical Companies

Source: Braake Consulting, Inc., March 2010

Company (Headquarters)	Sales 2009 (US$ million)
1. Pfizer, Inc.	2,764
2. Intervet/Schering-Plough	2,716
3. Merial	2,554
4. Bayer	1,400
5. Elanco	1,207
6. Novartis	1,100
7. Boehringer Ingelheim Vetmedica (estimate)	780
8. Virbac	670
9. CEVA (estimate)	470
10. Vetoquinol	360

Genomics-based animal technology

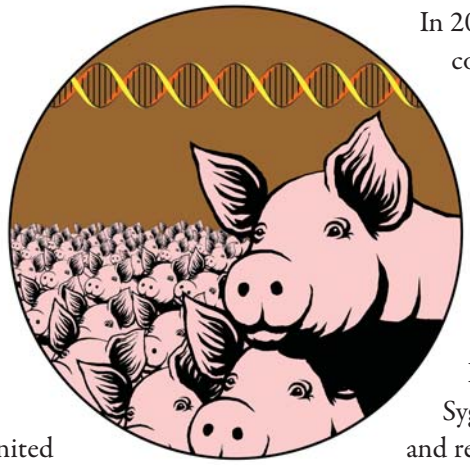
Igenity, the DNA testing division of Merial, is using genomics information to develop beef and dairy cow breeding stock. The company claims that its IGENITY profile identifies an animal's genotype as it relates specifically to genes. The genotypes detect Single Nucleotide Polymorphs (SNPs) that relate to variation in animal performance. According to the company: "The science behind IGENITY gives dairy and beef producers the ability to know now — with high accuracy — a new dimension of an animal's genetic potential for milk, and meat production and quality."[136]

Pfizer Animal Genetics

...is the global livestock genomics business unit of Pfizer Animal Health, a division of Pfizer Inc. According to Pfizer, the company's proprietary DNA-marker technologies can help identify genetically superior animals. In January 2010 the company announced a "significant milestone in the history of beef genetics" with the beef industry's first commercially available prediction-testing based on a High-Density panel of more than 50,000 DNA markers for black Angus. Pfizer claims that "DNA holds a wealth of information with important economic implications."[137] Pfizer Animal Health reported 2010 revenues of approximately $3.6 billion. But in July 2011 the parent company announced that it is "exploring strategic alternatives for its Animal Health and Nutrition businesses based on its recent business portfolio review..."

Livestock Genetics Industry

The "livestock genetics industry" – the companies that control breeding stock for commercial poultry, swine and cattle – is tightly concentrated in the hands of a few global players. There's no top 10 list for this industry sector because just three or four breeders dominate the market in livestock genetics for each major industrial livestock species.



The origins of commercial plant breeding and livestock breeding are closely related. Henry A. Wallace (Vice-President of the United States from 1941-45) – best known for developing hybrid corn – applied the same breeding methods to poultry: when two different lines are crossed, productivity of the offspring can increase, a phenomenon known as "hybrid vigour."

However, this effect is lost in the second generation, compelling farmers who adopt these breeds to buy new breeding stock year after year. It took only 10 years for all commercial poultry breeders to switch to poultry hybrids. By 1989, only eleven chicken breeding companies were left; by 2006 there were just four: EW Group (Germany), Hendrix Genetics (Netherlands), Groupe Grimaud (France) and Tyson (USA). Just three companies (EW Group, Hendrix Genetics, Groupe Grimaud) control the global market for layer hen genetics. Turkey genetics is controlled by EW Group and Hendrix, along with US-based Willmar Poultry Company.

In 2007 the world's leading poultry genetics company, EW Group, acquired Norway's Aqua Gen to become the world's leading salmon and trout breeding company.

Genus plc (UK) created the world's largest animal genetics company by acquiring the leading cattle genetics company, ABS Global, in 1999; the largest porcine genetics firm, Pig Improvement Company (PIC) in 2006 and Sygen International – a company that breeds and rears warm water shrimp. With 2010 revenues of $430 million, Genus operates in thirty countries on six continents.

With 2010 sales of $28.4 billion, Tyson Foods, Inc. is the world's largest processor and marketer of chicken, beef and pork. The company operates in 90 countries and contracts with 5,835 farmers to grow its animals. Tyson also owns Cobb-Vantress, making it one of the four companies that control the world market for broiler genetics. In 2010, the company slaughtered 42.3 million chickens, 143,600 head of cattle and 389,800 pigs per week.

With control of livestock genetics so tightly concentrated in the hands of a few industrial breeders, the number of commercial breeding lines has diminished sharply. Industrial breeds are based on proprietary genetics. The genetic make-up of the two dozen or so breeding lines used by industrial chicken growers worldwide is regarded as a trade secret.

Commercial Livestock Genetics – Leading Companies by Major Species

Broiler chicken	Cattle	Layer Hens	Pigs	Turkey
Erich Wesjohann Group (Germany)	Genus plc (UK)	Erich Wesjohann Group (Germany)	Genus plc (UK)	Erich Wesjohann Group (Germany)
Groupe Grimaud (France)	Koepon Holding (Netherlands)	Hendrix Genetics (owned by Bovans Beheer - Netherlands)	Hendrix Genetics (Netherlands)	Hendrix Genetics (Netherlands)
Hendrix Genetics (Netherlands)	Semex Alliance (Canada)	Groupe Grimaud (France)	Pigture Group (Netherlands)	Willmar Poultry Company (US)
Tyson (US)	Viking Genetics (Denmark)			

Source: Susanne Gura

To an astonishing degree, genetic uniformity is the hallmark of industrial livestock: A breeding cock can have 28 million offspring, a bull a million. Genus plc boasts that it has had 10 sires reach "millionaire" status (semen from a single bull account for 1 million+ offspring). In cattle and pigs, the genes of millions of animals correspond to less than 100 breeding animals ("effective population size"). One breed of cattle – the Holstein – accounts for over 90% of the US dairy stock. Thanks to artificial insemination, the entire Holstein population traces its lineage to no more than 20 animals.

In sharp contrast to the centralized control of industrial livestock genetics, an estimated 640 million small farmers and 190 million pastoralists raise livestock. Over centuries livestock-keeping communities have developed thousands of genetically diverse animal breeds, the source of traits such as disease resistance, high fertility and the ability to thrive in harsh conditions–essential resources for adapting to climate change. FAO estimates there are 7,616 unique farm animal breeds, but 20% are at risk of extinction, primarily due to growth of industrial livestock production.[138] We are losing one livestock breed per month.

FAO estimates there are 7,616 unique farm animal breeds, but 20% are at risk of extinction, primarily due to growth of industrial livestock production. We are losing one livestock breed per month.

Due to intensive production, overcrowding and genetic uniformity, industrial livestock operations are incubators for virulent infectious diseases. The human risks and economic losses associated with livestock diseases are staggering. According to the World Bank:

"Over the previous 15 years, 75 percent of the human diseases that have emerged as epidemics have been of animal origin and, overall, 60 percent of human pathogens are considered to be zoonotic [that is, animal diseases transmissable to humans]. A growing number of these pathogens are developing antibiotic resistance, and many of these animal pathogens have potential as bioterrorist weapons and pose the risk of intentional introduction into human populations."[139]

FAO estimates that the impacts of animal disease may affect 17% of livestock industry revenues in industrialized countries, and 35-40% of industry revenues in developing countries.[140] A 2001 outbreak of foot-and-mouth disease cost the UK government and private sector an estimated $25 to $30 billion; the 2002-2003 Severe Acute Respiratory Syndrome (SARS) outbreak cost China (including Hong Kong), Singapore and Canada between $30 and $50 billion.[141]

According to the Union of Concerned Scientists (UCS), seventy percent of the total antimicrobial drugs used in the United States is devoted to non-therapeutic use in livestock (e.g., antibiotics are used to make animals quickly gain weight – not to treat diseases). This widespread practice contributes to the evolution of antibiotic resistance in bacteria, including those that infect humans. UCS estimates that the amount of antimicrobials used for farm animals in the United States is about eight times more than those prescribed for human medical purposes.[142] The problem of antibiotic resistance in humans costs the US health care system an estimated $26 billion a year.[143]

Food Retail Industry

Big Food and the Bioeconomy

The world's biggest buyers, sellers and processors of bio-based products are the agro-industrial food manufacturers and retailers. How big? Globally, the size of the commercial food market topped US$7 trillion in 2009, overtaking the super-sized energy market (see page 11).

Key facts:

- The top 10 mega-grocery firms had combined sales of $753 billion in 2009. According to Planet Retail, the global market for global grocery spending topped $7.18 trillion in 2009. (Planet Retail claims that it monitors over 90% of the world's "modern grocery distribution," in over 200 countries.[144])
- With combined sales reaching $753 billion, the top 10 retail food firms account for about 10½ cents of every grocery dollar spent worldwide in 2009. (That's a big bite of the global market considering that the top 10 firms operated in just 65 countries in 2009.)
- The top 3 supermarket retailers – Walmart, Carrefour, Schwarz Group – account for 48% of the revenues earned by the top 10 companies, down from 50% market share in 2007.
- Walmart's grocery sales account for 25% of the revenues earned by the top 10 grocery retailers worldwide. In 2009, for the first time, Walmart's grocery revenues accounted for over half (51%) of the company's total sales.[145]
- The top 100 global food retailers tracked by Planet Retail had combined grocery retail sales of $1.84 trillion in 2009. The top 10 grocery retailers accounted for 41% of the revenues earned by the top 100 grocery retail firms. A single company – Walmart – accounts for 10.4% of the grocery revenues earned by the top 100.

Supermarkets Seeking Other Aisles

The biggest trend in grocery retail is no surprise: rapid growth in emerging markets outpacing sagging sales in the North. Industry analysts predict that China will out-consume the United States in 2012 to become the world's largest grocery market.[146] Brazil recently overtook France to become the fifth largest grocery market. By 2015, Brazil, Russia, India and China and the United States will claim the world's top 5 grocery markets. The combined grocery markets of Brazil, Russia, India and China will be worth an estimated €2,194bn (~$3 trillion) in just 4 years.[147] That's why supermarket titans are accelerating efforts to penetrate faster-growing markets in the South. (Note: Industry analysts do not consider the EU as a single market. The combined market share of the EU would place it much higher in the global ranking.)

World's Top 10 Food Retailers

Source: Grocery sales provided by Planet Retail, www.planetretail.net

Company (Headquarters)	Grocery Sales (US$ million)	Market Share (as % of top 10)	Number of countries of operation
1. Walmart (USA)	191,711	25.5%	15
2. Carrefour (France)	104,290	13.9%	34
3. Schwarz Group (Germany)	65,012	8.6%	23
4. Tesco (UK)	63,288	8.4%	14
5. Aldi (Germany)	62,268	8.3%	15
6. Kroger (US)	61,772	8.2%	1
7. AEON (Japan)	52,874	7.0%	9
8. Edeka (Germany)	51,625	6.9%	2
9. Rewe Group (Germany)	51,435	6.8%	14
10. Ahold (UK)	48,553	6.4%	10
Total Top 10	**752,829**	100%	

Their goal is to capture a dominant market share: "Increasingly, grocers are focusing on market share—if they cannot become No 1 or No 2 in a market, they look to make an exit," explains one analyst.[148] For example, Tesco operates in 14 countries, and 90 percent of the company's profits come from markets where it's the largest or second-largest supermarket.[149] To facilitate market dominance, the top 10 companies sometimes collaborate – rather than compete – by swapping assets. For example, in 2005 Tesco swapped stores in Taiwan for some of Carrefour's shops in Central Europe.[150]

Into Africa

In May 2011 Walmart got a green light from South African authorities to acquire a controlling interest in South African-based Massmart Holdings Ltd. for $2.3 billion. The chain is Africa's third largest retailer and operates in 14 sub-Saharan countries. Massmart is the first major acquisition by a top 10 retailer in sub-Saharan Africa. South African trade unions vigorously opposed the deal, refering to Walmart as "notoriously anti-union."[151] Michael Bride, the deputy organizing director of the US-based United Food and Commercial Workers' Union explains what's at stake for African workers: "Walmart exerts never-ending downward pressure on its suppliers to provide it with increasingly lower prices that simply aren't sustainable... In short Walmart's bad business practices don't just have an impact on workers in its retail stores, but [also] on workers up and down the supply chain."[152]

Great Wall-Mart of China?

Today Walmart operates 338 shops in 124 Chinese cities, with 90,000 employees and annual sales of approximately $7 billion. Sounds impressive, but it amounts to less than 3% of the company's US-based sales. The company's 2009 annual report predicts that its stores will buy from over one million Chinese farmers in 2011. "Walmart China firmly believes in local sourcing. We have established partnerships with nearly 20,000 suppliers in China," according to a Walmart China fact sheet, with over 95% of the merchandise in its China stores being sourced "locally."[153] (Of course, something similar could be said of the merchandise in its US stores – sourced from China, that is. Walmart is China's sixth largest export market, with more than 12 percent of China's exports to the United States ending up on Walmart shelves.[154])

As of June 2011 Carrefour operated a total of 184 hypermarkets in China. (By comparison, Carrefour had 232 hypermarkets in France as of April 2011.) Both Carrefour and Walmart recently made news in China after Chinese authorities fined the companies for overcharging or defrauding Chinese customers at multiple stores.[155]

Russian Retail Roulette

Analysts predict that Russia's grocery retail market will double in value over the next four years – taking it from seventh to fourth position worldwide. Today, Russian grocery chains account for only 40 percent of food sales across Russia. The world's number-two grocery retailer – Carrefour – opened its first Russian hypermarket, an 8,000 square metre store, in June 2009. Just four months later, despite plans to open a chain of giant stores, Carrefour decided to abruptly pick up stakes and leave Russia. The reason? The company's strategy was to invest only in countries where it could be a market leader – and prospects in Russia were not promising.[156]

Walmart is China's sixth largest export market, with more than 12 percent of China's exports to the United States ending up on Walmart shelves.

Eyeing India

India is under intense political pressure to scrap its national law that prohibits foreign firms from owning multi-brand retail chains. In the meantime, Carrefour, Walmart and Tesco are jockeying for top spots in India's giant consumer market – second only to China's – by establishing wholesale operations as joint ventures with local partners. Tesco is partnering with Tata, a national conglomerate; Walmart has a joint venture with Bharti Enterprises. In November 2010 US President Barack Obama travelled to India with an entourage of industry CEOs, including Walmart's Michael Duke, to lobby the Indian government to lift barriers on foreign direct investment.[157] What's India got to lose? After agriculture, retail is India's second-largest employer.[158] With an estimated 12 million small shops, mostly mom-and-pop (kirana) stores employing some 33 million people, India has the highest retail density in the world.[159]

Food and Beverage Processors

The top 10 food and beverage processing firms account for 37% of the revenue earned by the world's top 100 food and beverage companies.

The top 3 companies, Nestlé, PepsiCo and Kraft, together control a 45% share of the revenues generated by the world's top 10 firms; the three food & beverage behemoths control a 17% share of the revenues generated by the top 100 firms.[160]

In 2009, the global packaged foods market was worth an estimated $1,375,000 million ($1.37 trillion).

With combined sales of $387,551 million, the top 10 food and beverage firms control an estimated 28% of the global market for packaged food products.

With combined food revenues of $1,061,405 million ($1.06 trillion) in 2009,[161] the top 100 food & beverage firms accounted for an estimated 77% of all packaged food products sold worldwide in 2009.[162]

Less is More

Despite stagnant consumer demand in the North, volatile markets and extreme weather events, less turns out to mean more for food & beverage giants during the prolonged economic downturn. In 2009, 15 of the top 25 US-based food & beverage giants reported decreased sales, but 18 of the 25 saw *higher profits*.[163]

World's Top 10 Food Processors

Source: Leatherhead Food Research

Company (Headquarters)	Food & Beverage Sales, 2009 (US$ million)	Total Sales (US$ million)	Market Share (as % of Top 10)
1. Nestlé (Switzerland)	91,560	98,735	23.6%
2. PepsiCo (USA)	43,232	43,232	11.2%
3. Kraft (USA)	40,386	40,386	10.4%
4. ABInBev (Belgium)	36,758	36,758	9.5%
5. ADM (USA)	32,241	69,207	8.3%
6. Coca-Cola (USA)	30,990	30,990	8.0%
7. Mars Inc. (USA)	30,000	30,000	7.7%
8. Unilever (The Netherlands)	29,180	55,310	7.5%
9. Tyson Foods (USA)	26,704	26,704	6.9%
10. Cargill (USA)	26,500	116,579	6.8%
Total Top 10	**387,551**	**547,901**	100%

Investment Landscape Shifting

Foreign direct investment (FDI)* in all sectors of the global economy fell from a historic high of $1.9 trillion in 2007 to $1.69 trillion in 2008 – a drop of 14%.[164] According to UNCTAD, the financial crisis transformed the global investment landscape. South and emerging economies' share of global FDI inflows surged to 43% in 2008.[165] Investment outflows from the South and emerging economies accounted for 19% of global FDI – a trend that is reflected in the food & beverage industry (see M&A examples cited below). In 2009, FDI declined across all sectors and geographic regions. According to UNCTAD estimates, FDI recovered slightly in 2010, reaching over $1.2 trillion. Developing and transition economies attracted half of global FDI inflows, and invested one quarter of global FDI outflows.[166]

* *Foreign direct investment refers to a company's investment in a company or enterprise outside the investing firm's home country – usually via mergers & acquisitions.*

Merger and Acquisition Appetite Slows

In 2009, the food & beverage sector saw 1,005 M&A transactions valued at $43 billion – the value of deals was down 73% and the number of transactions fell by 37% from one year earlier.[167] Among the notable food & beverage deals in recent years:

- In 2008 the largest M&A deal was Anheuser-Busch's colossal $61 billion takeover of Belgian-Brazilian brewer InBev. The company (Anheuser-Busch InBev) is now ranked as the fourth largest food and beverage company in the world (and the world's biggest brewer). In 2010 the company generated revenues of $36 billion.
- In 2009, two of the top 5 deals involved Brazilian-based meat & poultry giants. Poultry processor Perdigão S.A. acquired its competitor Sadia for $5.6 billion, forming a new company known as Brasil Foods S.A.
- In 2010, Kraft Foods bought British candy maker Cadbury for $19.6 billion. Nestlé picked up Kraft's frozen pizza business in North America for $3.7 billion.
- PepsiCo became Russia's largest food & beverage firm when it acquired Russian juice and dairy company Wimm-Bill-Dann for $3.8 billion in 2010.
- In early 2011, DuPont acquired Danisco, a global enzyme and specialty food ingredients company, for $6.3 billion. (DuPont and Danisco previously shared a 50/50 joint venture to produce cellulosic ethanol.)

South Transnationals Go North

FDI activity in the food and beverage sector is also flowing North. For example:

- In 2008, the world's largest baker, Mexico's Grupo Bimbo, acquired US-based Weston Food for $2.8 billion. In 2009, Mexico's largest dairy, Grupo Lala, acquired National Dairy Holdings from Dairy Farmers of America, Inc. for approximately $440 million.
- In 2008, Brazilian beef processing giant JBS bought US meat packer Swift & Co. for $1.4 billion; in 2009, JBS swallowed Brazil's third-largest beef company Bertin SA, and took a majority stake in Texas chicken company Pilgrim's Pride for $800 million. After acquisitions in the United States, Australia, Europe and Brazil, JBS is the world's largest meat and poultry company. The company has the capacity to slaughter 90,000 cattle per day, with annual revenues of $29 billion.[168]

Emerging Economies Take Lead

Among individual countries, the United States accounted for the highest transaction value (174 M&A deals valued at $7.5 billion) in 2009. Brazil came in a close second with 15 transactions worth $7.1 billion. Ranked by the value of regional transactions, however, emerging markets took the lead. Asia led with M&A deals worth $11.1 billion, followed by Europe at $9.2 billion and North America at $8 billion.[169]

Water and the Agro-Industrial Food System

It takes a lot of water to grow the world's food. Agriculture accounts for some 70% of the world's fresh water consumption per annum. More astonishing is that, just five of the world's largest food and beverage processors consume about 575 billion liters of water a year, "enough to supply the daily water needs of every person on Earth."[170] "Virtual water" refers to all the actual water required to produce a product, ingredient or materials – including the water used to grow crops and feed animals. For example, it takes 2,500 litres of water to produce a single fast-food hamburger (0.15 kg).[171] The production and processing of 0.5 kg of chocolate uses 12,000 litres (3,170 gallons) of water.[172]

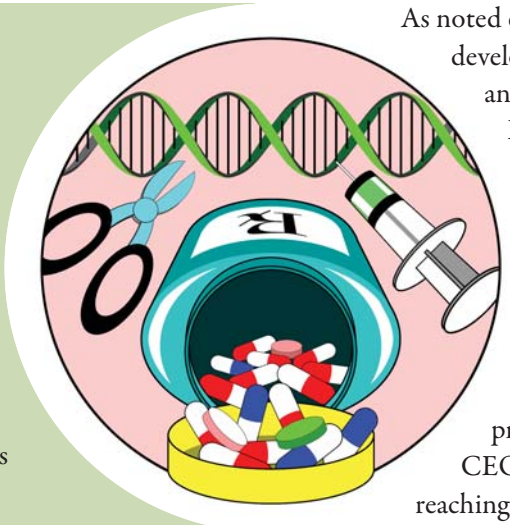
Trashed Biomass

Every year about one-third of the food produced for human consumption – about 1.3 billion tonnes – is lost or wasted.[173] According to FAO, in industrialized countries, food waste is mostly caused by retailers and consumers throwing edible foodstuffs into the trash. Consumers in rich countries waste almost as much food (222 million tonnes) as the entire net food production of sub-Saharan Africa (230 million tonnes). The amount of food lost or wasted every year is equivalent to more than half of the world's annual cereals crop (2.3 billion tonnes in 2009/2010).

The Pharmaceutical and Biotech Industries

Big Pharma, Biotech and the Bioeconomy

Big Pharma and its little brother, the biotech industry, are purveyors of proprietary products that have always depended on biodiversity and indigenous knowledge. It is conservatively estimated that at least 50% of the pharmaceutical compounds marketed in the United States are derived from plants, animals and microorganisms.



As noted earlier, the lines between drug development, bioinformatics, gene sequencing and diagnostics are blurring (see Bioinformation Industry, page 13), but the pharmaceutical industry still calls the shots. Today, Big Pharma employs biotech, genomics, nanotechnology and synthetic biology in pursuit of its long-promised and much-hyped "personal genomics" – where drug therapies seek to target a specific, genetically mutated protein that may cause specific diseases. The CEO of Roche gives his spin on the far-reaching technological promise of gene-based drug discovery: "...today's existing medicines address only some 150 targets, whereas there are more than two million proteins in the human body, of which many potentially can cause diseases. We are only scratching the surface."[174]

Note: In our 2008 *Who Owns Nature?*, sales of the top ten pharma companies accounted for 54.8% of the top 100 companies' 2006 sales. Based on 2009 sales of the top 100 companies, the top ten's share dropped slightly (52.3%). In 2009, the top ten companies accounted for 37.3% of all pharma sales worldwide, valued at $837 billion.

World's Top 10 Pharmaceutical Companies

Sources: Scrip Market Data, IMS Health

Company (Headquarters)	Sales 2009 (US$ million)	Share of Global Sales (%)
1. Pfizer (USA) – acquired Wyeth for $68 billion in 2009	45,448	5.4%
2. Sanofi-aventis (France) – completed $20 billion acquisition of Genzyme in 2011	40,871	4.9%
3. GlaxoSmithKline (UK)	37,134	4.4%
4. Novartis (Switzerland)	36,031	4.3%
5. Roche (Switzerland) – acquired Genentech for $47 billion in 2009	36,017	4.3%
6. AstraZeneca (UK)	32,804	3.9%
7. Merck & Co. (USA) – acquired Schering-Plough for $41 billion in 2009	25,237	3.0%
8. Johnson & Johnson (USA)	22,520	2.7%
9. Eli Lilly (USA)	19,964	2.4%
10. Boehringer Ingelheim (Germany)	16,890	2.0%
Total Sales of top 10 companies	**312,916**	
2009 Total global sales	837,000	37.3%

The features of the pharmaceutical sector we identified back in 2008 – big pharma's big bet on biotech, blockbuster drugs going off-patent, a clogged drug pipeline, a new focus on emerging markets and on personalized medicine – are all still in play, and all are factors in the loss of market share for the top 10 pharma giants:

- Roche's 2009 acquisition of Genentech – the world's first major biotechnology company founded 35 years ago – both symbolized and cemented big pharma's embrace of biotech. (Roche, the world's fifth largest pharmaceutical company, prefers "world's biggest biotech company" as a descriptor.)
- Between 2010 and 2014, big pharma will lose patent protection on drugs that contribute more than *$100 billion* to its revenue – an amount equivalent to 32% of the top 10 companies' combined pharma revenues.[175] The drug Lipitor, used to lower cholesterol, for example, loses patent protection in 2012 and brought in $11.4 billion for Pfizer in 2009 – that's more than a quarter of its total drug sales for the year.
- Plummeting off the patent cliff doesn't spell certain death for big pharma, however. Tweaking drug formulations and patenting the "new" drug can buy time; suing generic drug companies is an option, as is marketing "authorized" generics (i.e., putting its name and logo on generic formulations that fetch a higher price than non-branded generics). More frequently, though, big pharma opts to "pay-to-delay" – that is, they make cash payments to generic drug-makers for not bringing cheaper versions to market. In March 2011, the US Supreme Court ruled in favor of a pharma/generic company pay-to-delay pact, even though 32 US states and the Federal Trade Commission had filed friend-of-the-court briefs opposing the deal.[176]
- No rising stars are waiting in the drug-development wings. In 2009, sales of new drugs (drugs entering the market within the last five years), accounted for less than 7% of total drug sales.[177] One study found that less than one out of every 10 drugs reaching early-stage clinical trials today eventually make it to market.[178] In December 2010, Europe's top drug regulator cited the pharmaceutical industry's low level of successful drug innovation as a major public health concern and an enormous waste of money.[179]
- Emerging markets are still the great hope for big pharma. Historically, "the global pharmaceutical market" referred to markets in the United States, Europe and Japan; by 2025, those markets will account for less than half of the global market.[180] By 2015, China's drug market is expected to surpass Japan's to become the second largest market.[181]

iPharm?

According to market analysts Ernst & Young, the pharma industry has accepted that it must evolve.[182] No longer depending solely on proprietary, blockbuster drugs for its revenue (what E & Y describes as Pharma 1.0), the industry has already upgraded to "Pharma 2.0," evidenced by its diversified portfolios that include biotech-based drugs and branded generics. But Pharma 3.0 is right around the corner, where "a new generation of 'superconsumers' emerges empowered by the internet and mobile devices." The vision is for applications to turn mobile phones into medical devices – already, diabetics can link their glucometers and mobile phones to send glucose level data to their doctors – and for health care-specific social media to generate data that can be mined by patients, doctors and pharmaceutical companies. As E & Y sees it, in "Pharma 3.0, companies will not be selling pills as much as managing entire patient experiences."

That's what privately-held Voxiva, based in Washington, D.C. with offices in India, Mexico, Nigeria and Rwanda, is trying to do its HealthConnect Platform. Voxiva partners with companies or governments to connect with "end users" via SMS, e-mail, Internet or mobile phone for a two-way sharing of health information. Another company, California-based Proteus Biomedical, is testing its "chip in a pill" technology (called "Raisin"), which incorporates an "ingestible event marker" into a pill that sends out an electric charge when it comes in contact with stomach acid. A sensing patch on the patient's skin receives the charge and records the time and date that the pill was digested, along with heart rate and other vital signs. The information is sent to a mobile phone and then onto the Internet. Assuring patient compliance is the first intended application for the technology.

The World's Top 10 Publicly-Traded Biotechnology Companies

Source: Ernst & Young, *Nature Biotechnology*

Company (Headquarters)	2009 Revenue (US$ million)	% change from 2008
1. Amgen (US)	14,642	-2%
2. Monsanto (US)	11,724	3%
3. Gilead Sciences (US)	7,011	31%
4. Genzyme (US) Acquired by Sanofi-aventis 2011	4,516	-2%
5. Biogen Idec (US)	4,377	7%
6. CSL (Australia)	3,758	30%
7. Life Technologies (US) Formed by 2008 merger of Applied Biosystems and Invitrogen	3,280	102%
8. Shire (UK)	3,107	5%
9. Celgene (US)	2,690	19%
10. Cephalon (US) Acquired by Teva Pharmaceutical Industries 2011	2,192	11%

Identity Crisis

With big pharma continuing to absorb biotech companies, biotech as a discernable sector is fading fast. *Nature Biotechnology* notes that "much, if not most, of the biological products and biological techniques now resides outside the group of independent public companies" known as the biotech sector.[183] Big pharma spends an estimated $65-$85 billion a year on R&D, and 25-40% of that is devoted to biotech.[184] In the first half of 2011, big pharma scooped up two more of biotech's top 10: Sanofi-aventis acquired Genzyme for more than $20 billion; Teva Pharmaceutical will buyout Cephalon for $6.8 billion.

- Ernst & Young's 2009 survey of public biotech companies identifies 461 publicly-traded biotech companies worldwide.[185] The top 10 companies accounted for 62% of the sector's $91.7 billion revenues.
- For the third year in its 35-year history, the biotech sector as a whole posted profits – amounting to $8 billion in 2009. But the 13 largest biotech companies (revenues = $5 billion) accounted for 89% of the sector's net profits.[186] Casualties were steep. 34 companies dropped off the biotech list, 20 of those due to bankruptcy.
- In 2008, public biotech companies collectively spent $25.5 billion on R&D.
- 49% of the 461 biotech companies appearing on the 2009 list are based outside the United States. By comparison, only 17% of the public biotech companies were based outside the United States in 1998; 30% were non US-based in 2003; 36% in 2008.

Conclusion

In the face of climate chaos, financial and ecological meltdowns, and pervasive hunger, governments on the road to Rio+20 (EarthSummit 2012) are desperate to embrace a technological transformation (of any color) that promises a politically expedient Plan B for the planet. As currently envisioned, the green techno fix is seductive—but dangerous—because it will spur even greater convergence of corporate power and unleash a suite of untested, proprietary technologies into communities that are neither consulted about—nor prepared for—their impacts. Techno fixes are not capable of addressing systemic problems of poverty, hunger and environmental crises. In the absence of intergovernmental debate and extensive involvement from peoples' organizations and civil society, the Earth Summit will become the *Earth Grab*.

The goal is not to reject the Green Economy, but to build sustainable economies based upon the appropriate use of biodiversity to meet human needs and safeguard planetary systems. The now familiar axiom, "business as usual is not an option," must be reinforced by an equally important one: **governance** as usual is not an option.

Current governance structures for both the environment and agriculture in the United Nations system suffer from a lack of coordination among institutions; a lack of effective representation for most governments; and an absence of meaningful participation opportunities for civil society and social movements. First and foremost, Rio+20 will not succeed unless steps are taken to strengthen democracy and peoples' participation within the UN system. Governments must ensure the full participation of social movements – especially indigenous, farming and local communities – and civil society organizations. Efforts to counter corporate hegemony and build genuinely sustainable economies must include:

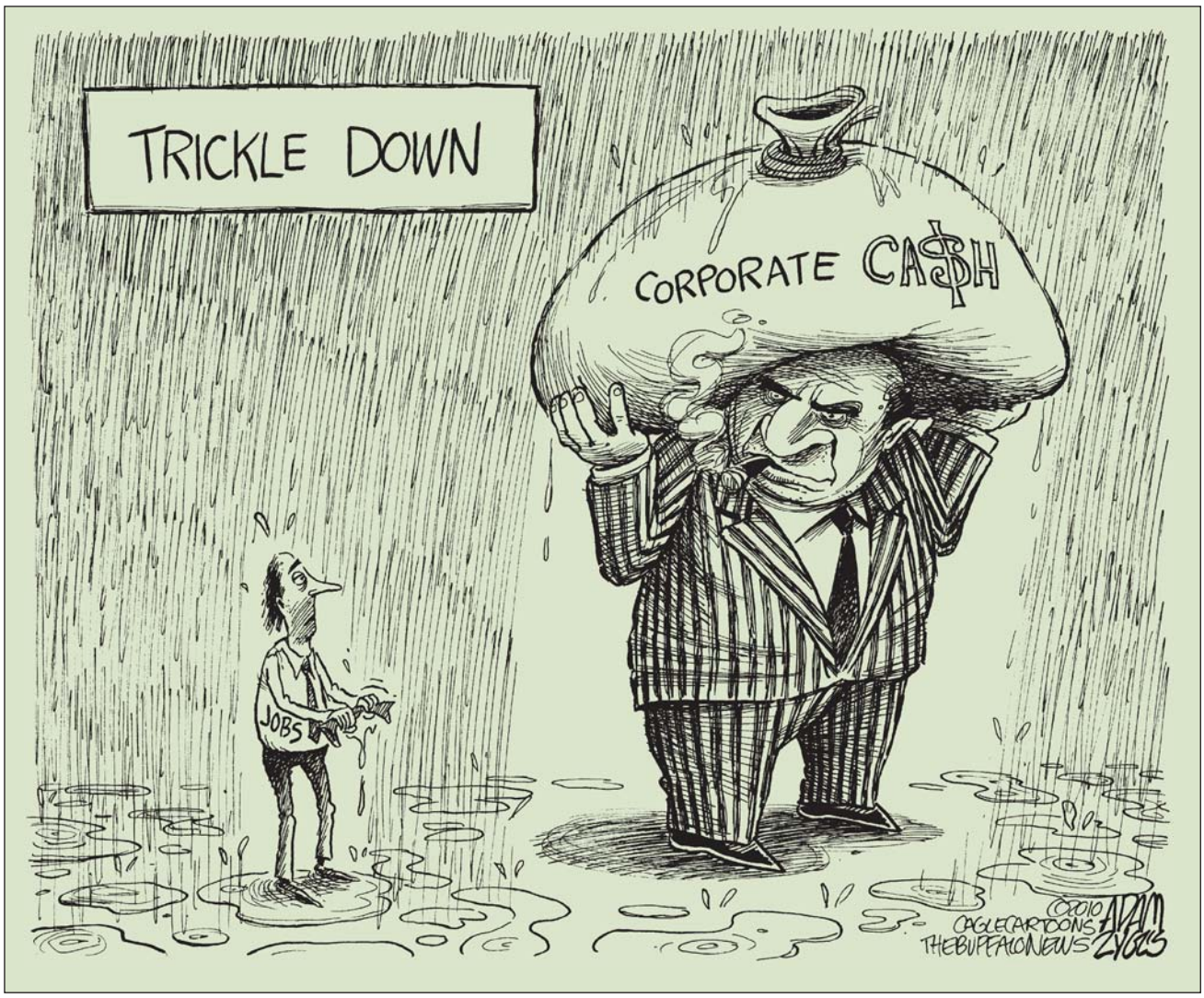
> ***"The globalisation of the food supply chains requires that competition law regimes be given extraterritorial reach, commensurate with the scope of activities of the market actors concerned."***
> – Olivier de Schutter, United Nations Special Rapporteur on The Right to Food, *Addressing Concentration in Food Supply Chains*, December 2010.

Anti-monopoly Regimes

Existing anti-trust structures are impotent in the face of ever-growing corporate consolidation and globalisation. A 2011 study by Swiss researchers reveals that 147 companies – which collectively form an economic "super-entity" – controlled *almost 40 percent of the monetary value of all transnational corporations* in 2007.[187] A 2010 report by the United Nations Special Rapporteur on The Right to Food recommends that competition law/anti-monopoly law regimes be expanded to facilitate the realization of human rights, including among others, the right to food, the right to work and the right to development. The UNCTAD Model Competition Law – though still a work-in-progress and not a supra-national anti-monopoly authority – is one effort to strengthen multilateral cooperation in the area of competition regimes (e.g., coordinated enforcement of competition policies). Governments must explore new, innovative models.

The Central Role of Agriculture and Food Sovereignty

In the negotiating process leading up to Rio+20, there is a troubling tendency for food and agriculture to be subsumed into a wider "environmental" agenda that ignores the recurring global food crises and the links between industrial agriculture and the climate crisis. The importance of agriculture, and especially the role of small-scale producers, must be central to any discussions of a green economy.



Not only do small farmers account for at least 70 percent of global agricultural production, their collective actions represent our best hope for adapting to and mitigating climate crisis. International policymakers must bridge the current disconnect between food security, agriculture and climate policy, especially by supporting Food Sovereignty as the overall framework for addressing these issues. (In contrast to today's agro-industrial system, which enables international trade regimes and market forces to dictate food and agricultural policies, food sovereignty implies the rights of nations and peoples to democratically determine their own food and agricultural policies.)

International Technology Evaluation and Information

Governments meeting in Rio should adopt a process to negotiate/develop an international technology evaluation and information mechanism – based on the Precautionary Principle – that will strengthen national sovereignty and build capacity, especially in the global South, to assess the health, environmental, economic and social impacts of new and emerging technologies such as biotechnology, nanotechnology and synthetic biology.[188] An emerging technology such as geoengineering, which can be deployed unilaterally and is intended to affect a global system (i.e., climate), should not be allowed to advance in the absence of such a mechanism.

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4 The original Monsanto transferred its industrial chemicals division in 1997 to Solutia, Inc., during the same era (1996-1998) it paid out $8 billion acquiring plant biotechnology companies (e.g., Calgene, Agracetus) and conventional and hybrid seed companies (e.g., DeKalb Genetics, Holden Foundation Seeds). It then merged with Pharmacia & Upjohn in 2000, and the new company created a subsidiary focused on agriculture also called Monsanto, which it spun off in 2002.

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We operate at the global political level and have consultative status with several UN agencies and treaties. We work closely with other civil society organizations and social movements, especially in Africa, Asia and Latin America. We have offices in Canada, USA, Mexico and Philippines.

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In this report on corporate power, ETC Group argues that in the absence of effective and socially responsive governance and government oversight, the bio-based economy will result in further environmental degradation, unprecedented loss of biodiversity and the disappearance of the remaining commons.

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