Glossary No. 2: Agricultural Research

What's in a name?

(More than you might think)

GRAIN

Many of us often have to struggle with words and concepts that are used as though they have one single and simple meaning, while in reality they hide strong bias and very specific worldviews. Not surprisingly, they are usually biased towards the worldviews of those in power. There have also been words and concepts which were well-intentioned when coined but that have been corrupted over time through inappropriate usage, thereby acquiring more complicated connotations and implications. When we use these words, we often unwillingly but unavoidably become trapped in political and philosophical frameworks which block our ability to challenge the power that backs those views.

In the following pages, GRAIN takes a critical look at some such key concepts related to agricultural research. This follows an earlier effort to look at key concepts related to knowledge, biodiversity and intellectual property rights that we undertook in the January 2004 *Seedling*. Many of the following words and phrases look innocent enough at a first glance, but on deeper examination, we can see how they are used to serve particular agendas. Some are used to constrain us and lock us into a particular way of thinking, and others are used against us. This is not an exercise aimed at drawing final conclusions, but an invitation to deconstruct some definitions and start the search for new terminology and ways of thinking that may help us untangle some of the conceptual traps we are stuck in. Your comments are welcome.

GENE

Genes are the hereditary material or information found in the cells of living organisms. But the actual material form of the gene is elusive; no one has ever actually seen one. And our understanding of its role in biological function is constantly evolving; the models are getting more complex, and the simple, founding ideas, which paved the way for the biotech industry, are no longer credible.

The central dogma of the Life Science industry was first put forward by Watson and Crick in the

1950s. It says that our genes, aligned on a double helix of two chains of nucleotides (DNA), can be read like the code of a computer programme. The code is said to be simple and universal, with each trait determined by one or more genes: one gene one protein one function. But recent advances in molecular biology, in particular the mapping of the genomes of humans and other organisms, have not revealed the *"secret of life"*, rather they have revealed our ignorance in the face of life's profound complexity. We now know that biological function results from a much more complex model of genetic interactions taking place within the cell and between the organism's genome and its larger (virtually limitless) environment. Yesterday's so-called *"junk DNA"*, the large amount of DNA that does not code directly for a protein, is now recognised as playing a critical function in modulating gene function[1].

But as molecular biology moves towards a more ecological understanding of living organisms, in which the gene hinders the understanding of biologists, the gene continues to dominate scientific and popular discourse. Scientists and industry, clinging to outdated, linear genetic determinism, still speak about genes as the wellsprings of cures for disease and hunger. Every week comes a new announcement about the 'discovery' of some gene for some application. Money changes hands and stock prices go up. While the gene's currency is declining in scientific circles, it remains the centerpiece of a multi-billion dollar industry, whose future depends on a clean cut, predictable gene. Acknowledging the true complexity of genes and heredity would mean opening a Pandora's box of regulatory and biosafety nightmares, and death to the industry.

PLANT BREEDING

Plant breeding is the process of creating new plant varieties or populations through deliberate crossings and the selection of existing varieties. It is the process by which Pioneer and Cargill obtain new hybrids, and Burpee gets new flowers and ornamental plants. It is also what allowed the tremendous transformation of some weak and often poisonous weeds into important crops like corn, rice, wheat, beans, quinoa, teff, potatoes, cassava, and many others long, long before Cargill and Monsanto made an appearance. Every plant we eat and every crop that is sown is the product of plant breeding.

Throughout almost all the 10,000 year history of agriculture, *"plant breeder"* was synonymous with *"farmer"*. The patient and careful work of millions of farmers produced an endless wealth of crops and varieties, with their myriad colours, flavours, needs, uses, adaptive characteristics, sub-products, growth habits, and so on. Then, around one hundred years ago, scientists decided that farmers did not know a thing and claimed a monopoly over plant breeding. Farmers were told they were ignorant and their seeds worthless, while seeds bred by scientists (using the very same seeds of farmers they said were useless) were presented as all that were worth planting.

The result of this systematic undermining of farmers is well known: thousands of varieties have disappeared, agriculture has become deeply dependent upon irrigation, machinery and agrochemicals, farmers around the world disappear by the minute, hunger continues to grow, and the food we eat has lost flavour and diversity. Does this mean that scientists do not know how to breed? No, but breeding always has a purpose set by the breeder, and there is no single breeder or group of breeders that can respond to the needs of millions of farmers and people working under millions of different conditions and aiming at millions of different objectives. Drastically reducing the number of breeders will unavoidably result in limited choices, and *"scientific breeding"* unavoidably breeds homogeneity. In addition, as breeding is increasingly funded by private corporations, it increasingly serves the interests and objectives of those corporations.

So, it comes as no surprise that the actual and potential products of current 'scientific' plant breeding look like a list of weapons against farmers and consumers: seeds that force you to use a certain agrochemical, seeds that do not germinate, crops that yield drugs and poisons, crops that will not survive unless farmers apply huge amounts of agrochemicals, crops that can be shipped around the world but taste awful, crops that have unknown effects on other living beings, and so on. If we are ever going to eat what we need, as we like it, with a wide range of alternatives, without chemicals, and – most important of all – if farmers are ever to regain all the rights and responsibilities associated with being a farmer, plant breeding will have to be reborn as the task and art of millions around the world.

[1] For a more detailed discussion on gene function and the failure of the dogma, see Barry Commoner, "Unravelling the DNA myth", *Seedling*, July 2003, p 6. www.grain.org/seedling/?id=240

BIOFORTIFICATION

You would think that the nutritional content of crops would be a standard consideration in plant breeding. But, in the blind quest for yield, the scientists of the green revolution forgot that nutrition mattered. Now, suddenly, nutrition is on the agenda, fancily packaged as *"biofortification"* and linked to the glamorous technology of genetic engineering. The very institutions that stripped the nutritional content from farmers crops and fields are now getting millions of dollars to try and put the nutrition back in. Yet again, the complex problems of poverty and undernourishment are reduced to simple technological fixes – like enriching potatoes or rice with vitamins – that do little to help the poor, but breathe new life into the cash-starved research centres of the CGIAR.

The CGIAR has initiated a ten-year Biofortification Challenge Program to deal with *"micronutrient malnutrition"* of iron, zinc and vitamin A. Work towards this is designed as a global research project, HarvestPlus, focused on fortifying rice, wheat, maize, cassava, sweet potato and common beans. The project is coordinated by the International Centre for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI), with the participation of other CGIAR centres like IRRI, CIMMYT, CIP, ICRISAT, IITA and ICARDA. HarvestPlus also involves national agricultural research bodies and seeks partnerships with private seed and biotech companies to help distribute the seeds. All this in the name of the UN's Millennium Development Goal to halve the number of the world's undernourished by 2015. The first 4-year period of this project, which started in 2003, seeks funding of $50 million. Half of this has been donated by the Bill and Melinda Gates Foundation; the rest will come from World Bank, The US Agency for International Development, the Danish Government, the Asian Development Bank and others.

It is hard to feel optimistic about this high tech, high cost, piecemeal approach to enriching the food system. What really needs to be fortified is small farm agricultural systems and their diverse cropping systems that guarantee wholesome food. Likewise, local traditional systems of medicine need to be strengthened for health care. We need a holistic approach to addressing problems of hunger and malnutrition that face up to the root causes of poverty. Moreover, nutrition is not about merely filling empty stomachs with calculated doses of proteins and vitamins: it is nurturing the mind, body and soul; it is about respecting life.

Jargon buster

CGIAR: the Consultative Group on International Agricultural Research. A group of donors established the CGIAR in the early 1970s to fund agricultural research around the world. It does this via 16 International Agricultural Research Centres, which now call themselves "Future Harvest" centres comprising more than 8,500 scientists and support staff working in more than 100 countries. The CGIAR is the biggest institutional force guiding research and development for the crops that feed people in the South. As government funding is drying up, the CGIAR is increasingly looking to partnerships with industry to keep itself alive: hence its growing interest in research into GM crops.

FAO: The United Nations Food and Agriculture Organisation. Founded in 1945, the FAO's mission is to lead international efforts to defeat hunger. In the 70s and 80s, the FAO seemed to take a real interest in the concerns and needs of small farmers, and was the only international forum to seriously take on the issue of Farmers' Rights. But more recently, it has lost any credibility it had amongst farmers' groups around the world for its public backing of the agricultural industry as a force to overcome hunger. It has recently come under serious attack for coming out in favour of genetic engineering as a useful tool to combat hunger around the world.

Cartagena Protocol on Biosafety: the first international treaty dealing with the movement of genetically modified organisms (GMOs) across country borders. The protocol was drawn up under the Convention of Biological Diversity and came into force in September 2003. So far, 103 countries have ratified the agreement. Although the biosafety protocol was pushed for by the South and drafted as a promise of legal protection *against* the introduction of GMOs, the weakness of its provisions means that the protocol and the national biosafety laws that have been born of it are being steadily turned into tools to facilitate the introduction of GMOs.

Green revolution: the name given to the agricultural modernisation programme that swept across the South, and Asia in particular, in the 1960s and 1970s. Initiated by Northern institutions and powered by the CGIAR, it encouraged countries to shift to monoculture farming dependent on chemical fertilisers and pesticides with the purported goal of increasing yields and agricultural profitability. The 'gene' revolution is merely the latest incarnation of the green revolution.

CONTROLLED CONDITIONS

The scientific method tells you that if you want to test the effects of any factor, you must keep all other conditions fixed. It also rules that any condition that changes must do so in a way that is measurable to the researcher. This is possible only if you work under so-called *"controlled conditions"*. To determine the effect of a fertiliser on crop yield, you must maintain a controlled and uniform level of water availability, a set distance between plants, uniform soil conditions, and so on. You also have to spread the fertiliser in such a way that every plant gets the same amount.

Any farmer will tell you that this is impossible. So, what do scientists do? They either create highly artificial conditions by using very small plots, or work in greenhouses or growth chambers, and/or compensate for irregularities by setting up conditions which are way over saturation levels. If the water permeates unevenly, then saturate the plot, even if it means wasting water. If you can´t spread fertiliser evenly, then use up to ten times what is needed, to ensure that every plant gets at least as much as it can handle.

Any farmer will now tell you that it may be possible to farm this way, but it is very expensive, inefficient, wasteful and most often impractical. This means that research is done under conditions that no or very few farmers will be able to – or want to – reproduce, making the value of the research meaningless or extremely limited. But here comes the second part of the alchemy. Farmers are told that good farming implies creating the same conditions as those created by the researcher. The message is that if scientists fail to imitate real farming, then farmers have to imitate the lab. Never mind that on the way there, farmers destroy their soils, poison themselves, contaminate the environment, lose income, and – worst of all – become indebted and dependent. 'Controlled conditions' lead to controlled farmers.

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Farming is by definition the art of dealing with the unpredictable. What scientists define as uncontrolled conditions are the web of relationships that make agriculture, productivity and sustainability possible. Sound research should learn about those relationships, not delete them.

HIGH YIELDING

For half a century, *"high yielding"* has been the catchphrase for many in the business of fighting hunger and poverty. The logic goes like this: We need to produce more food for more people around the world. With only so many more forests and savannas to plough, we need to increase yields on existing farmland. For this, we need scientists to breed high-yielding seed varieties for farmers. This is the rationale for the 'green' and 'gene' revolutions that have been pushed into farmers' fields over the past 40 years.

It seems so simple and straightforward, but a few salient questions show that things are not that simple. The first one is: what is *"high"*? Under which conditions do we get high yields, and with what consequences? The 'miracle varieties' of the green revolution were not inherently high yielding; rather they were highly responsive to chemical fertilisers. They were bred to produce more grain than traditional varieties and with shorter stems so that they didn't fall over with the extra weight they bore. But they were also more susceptible to pests and diseases, requiring heavy doses of pesticides. They also needed lots of water, and good soil. Without these conditions, there was nothing high yielding about them. And even under such conditions, the high yield was offset by the high cost of chemicals that ended up undermining the very productivity they were meant to promote.

The other question is: what is *"yield"*? An agronomist will tell you that yield is the number of kilos that you harvest from a hectare of a given crop. But from the perspective of many farmers, the answer is a much more complex. First, typical yield statistics only reflect the yield of the main produce. In the case of cereals, it's all about grain. But what about the straw that is so important to keep the soil in shape and the animals happy? And how valuable are all those extra kilos if they come at the price of decreased nutritional content and less taste? The yield factor gets even more skewed when you consider that most farmers in the world inter-crop. They might plant maize and beans together, harvest fruit from the trees in the field, collect weeds to weave baskets from, and grow vegetables and medicinal plants. The maize yield statistics of these farmers might be miserable, but there is plenty of food.

The simplistic and narrow 'high yield' approach ignores many complex productivity issues. Because of this, it undermines food production and food security by promoting monocultures and doing away with everything else that people use or eat.

IDENTITY PRESERVATION

Identity preservation is all the rage in multinational agribusiness circles these days, even though it has yet to make much of a dent in the agricultural and food systems outside North America. The term refers to a system of certification that keeps a crop of a certain variety segregated from other varieties from the farm to the consumer. Identity preservation systems are not organic certification systems; they are concerned with maintaining a 'pure' product, whereas organic certification is concerned with the farming process.

There are three major forces driving the growth of identity preservation systems. The first is the corporate restructuring in the agri-food industry. With the growing concentration and power of the retail food sector over the past few decades, other players are looking for ways to leverage themselves against the retail giants. Their main strategy for doing so is vertical integration (mergers and alliances) with upstream and downstream companies, based on the control of key proprietary technologies, such as seeds. The idea is to create supply chains, managed by a system of contracts at every stage of production.

The second driving force behind identity preservation is the popular rejection of GM crops. Food companies are interested in identity-preservation systems in North America because they offer a way to segregate GM and non-GM crops. But unlike the co-existence systems proposed in Europe, identity preservation systems put the added costs for segregation on the non-GM stream.

The third force is the seed industry. In a recent survey, seed industry leaders in Canada listed hybrid seeds and identity-preservation as the best ways of preventing farmers from saving seeds. When farmers enter an identity preservation system they must sign a contract that prevents them from saving their seeds. The seed industry also sees identity preservation as a way to extract downstream royalties. They imagine that one day food products will have to indicate the variety name and that consumers and food processors will have to pay royalties to them accordingly.

Identity preservation is being sold to farmers with promises of premiums and set prices. But the bigger picture is of more contract growing controlled by transnational corporations, further criminalisation of seedsaving, and GM-free food as a niche market exclusively for the very rich.

PARTICIPATORY RESEARCH

Behind the attractive epithet of *"participation"* usually lurks the all-too-familiar patterns of dominance and control shaped by the mantras of *"modern"* and *"progressive."*

The first questions we should ask in agricultural research are *"What for?"* and *"How?"* But these two central questions are almost always answered in research centres and most of the time 'participation' is limited to the execution of tasks already determined in other places, and to very limited aspects of the research. It is often reduced to an almost passive role of processing the analysis and evaluations of research undertaken by others. While it may start out with the best of intentions, participatory research often merely perpetuates old practices and power relationships that contribute nothing to communities' autonomy and food sovereignty.

Participation cannot be addressed without facing up to the question of power relationships between researchers and the community. Other prerequisites for participatory research are a clear intention from the community to take on the research, its involvement in determining what levels of external support are needed, and a leading role in formulating all the stages of the research process.

We must never forget that people all around the world have generated the immense biological diversity that nurtures and sustains us. Research is nothing new to farmers and communities – and their approaches have been much more participatory than anything on offer from today's technicians. Maybe the latter should start by learning about these practices to change the dynamics of current research.

Carinne Pionetti

Successful participatory research starts with communities, not from outside.

SOUND SCIENCE

When George W. Bush and members of his administration talk about environmental policy, the phrase *"sound science"* rarely goes unuttered. Sound science is the foundation of the US' risk assessment policy for genetically modified foods. So far, so good. Who can argue against sound science? Well, the EU, for one. A US State Department press release from March 2003 criticised the European Union for making decisions on agricultural biotechnology based on *"fear and conjecture, not science."* Fear maybe, but fear of US sound science more than fear of GM foods themselves. The EU finds more comfort in the precautionary principle than the US' less-than-reassuring murmurs about sound science.

Sound science is part of a growing lexicon used to put a pro-science veneer on policies that most of the scientific community tends to be up in arms about. It is a completely subjective term invoked to mean requiring an extremely high burden of proof before taking government action to protect public health and the environment. As such, it is not a scientific position at all.

A short history of the phrase *"sound science,"* and its development into a mantra of the political right, clearly demonstrates its anti-regulatory, pro-industry slant. Strategic uses by the business community trace back at least to Dow Chemical's 1983 launch of a $3 million program to allay fears of dioxin pollution that would use sound science to *"reassure"* the public - i.e., downplay risks. The term gained further repute in 1993 when tobacco giant Philip Morris created a non-profit front group called The Advancement of Sound Science Coalition to fight against the regulation of second hand smoke. Since then, many other industry groups have invoked sound science to ease government restrictions.

If the climate change debate is anything to go by, sound science means howling at a waning moon. In 2002, Republican congressional candidates in the US received a memo from strategist Frank Luntz telling them that *"The most important principle in any discussion of global warming is your commitment to sound science."* Most intriguing was what sound science actually meant to Luntz with respect to climate change. *"The scientific debate is closing but not yet closed,"* he said. *"There is still a window of opportunity to challenge the science."* What he was calling for was paralysis by analysis – to delay political action – and nothing to do with science at all.

SUBSTANTIAL EQUIVALENCE

Substantial equivalence is the subjective concept underlying the regulation of GM crops and food in the name of *"sound science."* In practice, it might be more appropriate to characterise the concept as: 'If it looks like a duck, walks like a duck, quacks like a duck and tastes like a duck, then it must be duck. But don't ask what it has been fed.'

The concept was first introduced in 1993 by the Organisation for Economic Cooperation and Development (OECD), and was endorsed by the FAO and World Health Organisation in 1996. The 1993 OECD document says that, *"The concept of substantial equivalence embodies the idea that existing organisms used as foods, or as a source of food, can be used as the basis for comparison when assessing the safety of human consumption of a food or food component that has been modified or is new."*

Behind the undefined concept of substantial equivalence lies the dilemma of the biotech industry when it was preparing to introduce GM crops and foods to farmers and the public. The industry needed its products to be regulated in order to gain public acceptance, but it did not want regulation to impede the marketing of its products. At the same time, it needed to establish the novelty of its products for patent purposes.

So instead of describing GM seeds and foods as such, the compliant regulators came up with the delightfully vague term, *"novel foods,"* to describe the products of genetic engineering. It is important to note that the assessment of these novel foods was of the product only. The process by which they were produced (and became *"novel"*) was conveniently ignored. In this way, genetic engineering became characterised as just a marginal extension of traditional genetic modification of plants, as plant breeding was renamed.

These novel foods could then easily be characterised as substantially equivalent to traditional foods because neither concept had any concrete definition and the questions that should have been raised by the genetic engineering process itself were not even asked. Thus the question of unintended side (pleiotropic) effects caused by the *process* of genetic engineering is simply ignored. This is topped off with the adamant refusal to label the products of genetic engineering, thus eliminating the possibility of identifying cause-and-effect if there are unexpected and deleterious effects.

All the companies had to do then was describe for the regulators the particular genetic trait they had added to the product submitted for approval on the discredited grounds that each gene is responsible for a single distinct trait (see the 'gene' discussion above). The companies simply had to characterise what they claimed to be the isolated gene for the desired trait, ignoring the essential genetic companions of the genetic trait itself; the vector (the insertion vehicle), the genetic switches and promoters, markers (genes for antibiotic resistance) and quite possibly other unidentified genetic material, such as viruses.

Quite apart from these huge oversights, even the rudimentary characterisation of the altered or added gene construct that is required has not always been honest or complete. In the case of recombinant Bovine Growth Hormone, Monsanto got approval for a construct which was not identical to its natural counterpart, differing by three amino acids. It was definitely not substantially equivalent, even by the regulatory authority's crude assessment. Monsanto also got approval for RR soybeans that were mischaracterised, as the company later admitted. The regulators simply took the company at its word when they declared the plants substantially equivalent.

Substantial equivalence is a very forgiving tool. Does it look and taste like a duck?

BIOTECHNOLOGY

A popular definition of biotechnology is "*any technique that uses living organisms or substances from these organisms to make or modify a product for a practical purpose*"[2]. This rather meaningless definition is so broad that it could even include agriculture itself. Usually the description carefully points out that this technology has been around for many millennia, ever since people started making bread and wine – this is important in making the term seem benign. It then continues with a long list of possible benefits biotechnology could deliver to farmers: raising yields, improving resistance to pests, diseases, drought and cold, and so on ….

The comment then follows that genetic engineering is just one technique in a whole toolbox of new and not-so-new biotechnologies that could help farmers, pointedly including conventional plant breeding. And the assurance follows (almost as an afterthought) that biotechnology complements other approaches to achieve a productive and sustainable agriculture, and a better living for poor farmers. Technology alone cannot solve hunger, it concludes, but we should use all the tools at our disposal. This definition is tidy, politically correct, and designed to keep everybody happy.

But this way of defining biotechnology does two things that confuse and mislead. On the one hand it buries the key concerns about genetic engineering and corporate control in a hazy heap of techniques and considerations – very cleverly used by those who stand to gain from this technology. And on the other hand, despite all the talk of toolboxes and choices, virtually the only kind of biotechnology being practiced and dumped on farmers worldwide is genetic engineering. Less than a handful giant corporations are pushing a handful of transgenic crops on farmers and consumers around the world.

Now that *"biotechnology"* has softened the image of genetic engineering, the term *"modern biotechnology"* has been establishing itself in the lexicon. The Cartagena Protocol on biosafety, for example, only addresses the products of modern biotechnology, by which it means only those techniques that overcome natural reproductive barriers and are not used in traditional breeding and selection, meaning genetic engineering and cell fusion. The hope of the GM lobby is that by using the term *"biotechnology"* we will view genetic engineering as merely a sophistication of the techniques developed thousands of years ago for wine and cheese making, instead of the crude, revolutionary and risky experiment that it is.

[2] FAO, *The State of Food and Agriculture 2003-2004: Agricultural biotechnology meeting the needs of the poor?*, FAO, Rome, 2004, p 8. www.fao.org/docrep/006/Y5160E/y5160e00.htm