GM crops: rebuttal of claims on safety and benefits

By Claire Robinson, Corporate Europe Observatory
June 13, 2016*

In recent times we have seen various examples of green activists "coming out" as GMO-proponents, arguing that GMOs are safe and have multiple benefits: reduced pesticide use, higher income for farmers, contributing to food security, reduced greenhouse gas emissions. As an essential part of their discourse, organizations that continue to reject GMO technology are depicted as old-fashioned and as acting in contradiction to their own aims. But there are many fundamental flaws in the argumentation they are putting forward. In a guest article, Claire Robinson of GMWatch rebuts many of the claims made by those green activists who have recently come out as GMO-proponents.

Mark Lynas is a well-known example of this in the UK, with an (in)famous public apology for his past role in the anti-GM movement that drew a lot of media attention. This entry-point has proven quite attractive to the media, and Lynas' move has been copied by others, like blogger Stijn Bruers in Belgium. However, it is not clear why specifically these people are seen to have the credentials to merit this attention.

There are many fundamental flaws in the argumentation they are putting forward. Claire Robinson of GMWatch, at the request of Corporate Europe Observatory, has written a rebuttal of many of the claims made by these newly converted GMO proponents. For practical reasons, this rebuttal follows the argumentation and claims made in an article by Bruers on his blog about GMOs. [Author: Claire Robinson, November 2015]

1. GMO foods and crops pose health risks

Scientific organizations

Stijn Bruers' article starts with an appeal to authority in claiming GMOs are safe, that doesn't stand up to scrutiny. He cites a number of respected scientific organizations, including the American Association for the Advancement of Science, the American Medical Association, and the United States National Academy of Sciences, which, he implies, concur that GMOs are safe.

The problem with this argument is that over 160 expert organizations have variously stated that GMOs have not been proven safe, and/or have supported mandatory GMO labelling.

For example:

The IAASTD report on the future of farming, co-authored by over 400 international experts and sponsored by the UN and World Bank, concluded

> "The safety of GMO foods and feed is controversial due to limited available data, particularly for long-term nutritional consumption and chronic exposure. Food safety is a major issue in the GMO debate… The concepts and techniques used for evaluating food and feed safety have been outlined… but the approval process of GM crops is considered inadequate."

The Royal Society of Canada (RSC) criticized the internationally widespread use of the concept of "substantial equivalence" as a tool to exempt GM agricultural products from rigorous scientific assessment. It said that this practice (which dominates GMO regulation in Europe, where it is called "comparative assessment", as well as other countries) is "scientifically unjustifiable and inconsistent with precautionary regulation of the technology". The RSC added that the "default prediction" for every GM food should be that the introduction of a new gene would cause unanticipated changes, such as the production of new allergens.

The British Medical Association concluded, “many unanswered questions remain… with regard to the potential long-term impact of GM foods on human health and on the environment.”

Bruers cites the position of the American Association for the Advancement of Science (AAAS) as evidence of GMO safety. It’s true that in 2012 the board of the AAAS, headed by GMO promoter Nina Fedoroff, issued a statement claiming GM was “safe” and opposing the mandatory labelling of GM foods in the US, which it said “can only serve to mislead and falsely alarm consumers”.

But Bruers fails to mention that the statement was promptly condemned by 21 scientists, including many members of the AAAS, as “an Orwellian argument that violates the right of consumers to make informed decisions”. And subsequently Fedoroff was revealed by emails disclosed as a result of freedom of information requests to be working hand-in-hand with the GMO industry to promote its products.

Bruers implies that the World Health Organization believes GMOs are safe. But this is false. The WHO has indeed stated: “No effects on human health have been shown as a result of the consumption of GM foods.” But no health monitoring of people eating GM foods has ever been carried out – so it is not possible for health effects to be seen. What is known is that the health of people in the USA has worsened markedly since GM foods were introduced there in the mid-1990s. GM foods are not labelled there, so no one knows if there is a link with GM foods. But such a link cannot be ruled out.

Bruers carefully avoids quoting the context of the WHO statement. The WHO went on to say, “Individual GM foods and their safety should be assessed on a case-by-case basis… it is not possible to make general statements on the safety of all GM foods.” This is a statement with which many opponents of GM foods would agree.

Bruers also misrepresents the position of the American Medical Association (AMA). In fact the AMA is a critic of the current GMO regulatory system in the USA, calling on the US Food and Drug Administration to require “pre-market systemic safety assessments of these [GM] foods as a preventive measure to ensure the health of the public.” Yet currently, there is no mandatory pre-market safety testing or assessment in the USA for GM food – only a voluntary consultation in which the FDA looks at whatever data the company wishes to provide and states that the company – not the FDA – may be liable if it puts unsafe food onto the market. The US EPA and USDA only involve themselves in the assessment process insofar as they judge the GMO to be a pesticide (as in the case of Bt crops) or a plant pest, and their oversight and requirements are minimal.

Often-cited "review studies" on 'GMO safety' and 'reduction of pesticide use'

Bruers cites two "major review studies" that converted him to the cause of GMOs:

A review by Nicolia and colleagues (2014) of 1783 articles on GM crop safety research, which claimed to find no "significant hazards" connected with such crops.

The meta-analysis by Klümper and Qaim (2014), which claimed a 37% reduction in chemical pesticide use from GM crops overall and a 42% reduction from Bt insecticidal crops (in which the insect-killing toxin is engineered into the plant). (See section on pesticide use).

However, these reviews mislead readers. They offer no grounds for reassurance about pesticide use on GM crops or about GMO safety – and the second actually provides evidence of GMO hazards. A detailed analysis follows.

1. Nicolia and colleagues' (2014) conclusions on GMO safety

The review by Nicolia and colleagues cited by Bruers is widely used to argue that over 1700 studies show GM foods and crops are safe. However, the studies cited in the Nicolia review and supplementary materials, taken as a whole, do not show that GMOs are safe and some of the studies provide evidence of risk or actual harm from GMOs.

The majority of the articles in the list of 1700 are irrelevant or tangential to assessing the safety of commercialized GM foods and crops for human and animal health and the environment. The list contains many animal production studies, often performed by GM companies on their own products. These do not examine in detail the health impacts of GM feed but look at aspects of animal production of interest to the food and agriculture industry, such as weight gain and milk production.

While such studies provide the agriculture industry with useful information about whether an animal fed on the GMO will survive to slaughter age and deliver an acceptable meat or dairy product, they are usually short-term in comparison to the animal's natural lifespan and provide no detailed information about the health of the animal.

Many of these studies are performed on animals such as cows, fish, and chickens. The digestive systems and metabolic functioning of these animals differ significantly from those of humans. Thus these studies are unlikely to provide useful information on human health risks.

The list includes some studies that are relevant to GMO safety and show actual or potential hazards of the GMO to health or the environment. The Nicolia review authors ignore or dismiss these findings without sound scientific justification. They also ignore evidence contradicting key assumptions upon which regulators have based their conclusions that GMOs are safe and major controversies over the interpretation of scientific findings on GMOs.

Nicolia and colleagues also omit important studies that demonstrate hazards related to GMOs. They use unscientific justifications for ignoring or dismissing important papers, including their arbitrary decision to include only studies published in the ten years since 2002.

Assembling questionable "Big Lists of Studies" supposedly providing evidence of the safety of GMOs has become common practice by GMO proponents. The aim of the practice is not to open scientific debate but to. But in the long term it will have a corrosive effect on public trust in science.

A detailed and fully referenced analysis of the Nicolia review, detailing all the points made above, has been published in the report, GMO Myths and Truths. The report also summarizes many studies showing known hazards and potential risks of GM crops and foods.

A comprehensive list of over 1800 scientific studies and articles indicating hazards and uncertainties relating to GM crops and their associated pesticides has been assembled by the NGO, GMO Free USA.

All those who consult and use "Big Lists of Studies" on either side of the debate should form their own conclusions by actually reading the studies cited. More on the "Big lists": see Annex I.

No scientific consensus on GMO safety - continued

There is no scientific consensus on GMO safety. A statement attesting to this fact, signed by over 300 well-qualified scientists, cites comprehensive reviews of numerous animal feeding studies that cast doubt on GMO safety. The statement concluded, "Claims of consensus on the safety of GMOs are not supported by an objective analysis of the refereed literature."

Contrary to Bruers' implication, animal feeding studies finding toxic effects and signs of toxicity are not restricted to the two studies led by Gilles-Eric Séralini and Judy Carman.

For example:

Dona and Arvanitoyannis (2009) concluded, "The results of most studies with GM foods indicate that they may cause some common toxic effects such as hepatic, pancreatic, renal, or reproductive effects and may alter the hematological, biochemical, and immunologic parameters."

A 2015 review highlighted 26 animal feeding studies showing harmful or potentially harmful effects of GM foods and concluded that unless and until these studies are replicated and shown to indicate false positives, "The putative consensus about the inherent safety of transgenic crops is premature."

A factor that fuels scientific concern about GMO food safety is the relative rarity of controlled long-term animal feeding studies on commercialized GM crops. In 2012, in the wake of the Séralini study, which found toxic effects in liver and kidney and hormonal disruption from GM maize and Roundup fed to rats over a long-term period, the French food safety agency ANSES conducted a search for comparable long-term studies on glyphosate-tolerant GM crops, which make up over 80% of all commercialized GM crops worldwide. ANSES found only two studies.

One of these studies found toxic effects from feeding GM soy to mice. The other, by Japanese researchers, found no significant effects from the GM soy fed to rats. However, the researchers appear to have fed GM soy that was not sprayed with Roundup during cultivation, since glyphosate residues were not detected in the soy.

This absence of glyphosate residues in the GM soy in the Japanese study runs contrary to the findings of analytical tests of GM soy on the market. The first of these two analyses found levels of residues that are so high that Monsanto previously called them “extreme”, while the second found levels that are above regulatory levels deemed safe.

The Japanese study therefore is unlikely to reflect real-world farming practices.

In conclusion, out of three long-term feeding studies with glyphosate-tolerant GM crops, two found toxic effects and the other appears to have tested irrelevant material.

No consensus on GMO safety among medical scientists

Bruers states: “There is no strong evidence that current GM crops are less healthy than conventional crops. There is a strong consensus among medical scientists that GM crops do not pose a greater threat than conventional crops. The safety tests on GMOs are usually stricter than for new crops with conventional plant breeding techniques, and it seems that is no reason to do so. The scientific consensus is based on hundreds of independent studies that have no conflicts of interest and not sponsored by the GMO industry. About half of the GMO studies independently. (A number of studies indicating risks of GMOs – e.g. those by Gilles-Eric Séralini – were funded by environmental organizations). Unfortunately, unreliable, pseudo-scientific studies are still often cited. Thus, a petition article that casts the scientific consensus in doubt refers to the rat experiments by Gilles-Eric Séralini and the pig experiments by Judy Carman. That petition article was signed by more than 300 researchers, but the infamous Oregon Global Warming Petition Project was also signed by several hundred climate skeptic scientists.”

This statement is full of inaccurate claims that will be addressed below and in the next sections.

There does not appear to be any evidence to support Briers' specific claim of a consensus among "medical scientists" that GM crops are as safe as conventional crops. On the contrary, organizations of health professionals have critiqued current GMO safety assessments, issued warnings about GMO safety, and/or called for mandatory GMO labelling. For example:

The British Medical Association has expressed a warning about the "many unanswered questions" about the long-term effects of GMOs on health and the environment.

The American Medical Association has called on the US Food and Drug Administration to require "pre-market systemic safety assessments of these [GM] foods as a preventive measure to ensure the health of the public" – yet such assessments are not performed in the US.

The American Public Health Association (APHA) supports GMO labelling, citing "concerns related to human exposure to and consumption of these [GMO] plant proteins".

The Public Health Association of Australia has called for long-term animal safety studies with GM foods, GMO labelling, and surveillance systems to monitor for possible effects of GM foods on health. Such long-term studies are not required by any regulator in the world and surveillance systems for health effects do not exist anywhere.

The Bundesärztekammer (German Medical Association) has called for mandatory GMO labelling, as health risks "cannot be ruled out".

Surveys of medical and health professionals contradict Briers' assertion of a consensus among medical scientists that GMOs are safe.

In a 2013 survey of 200 medical doctors, 80.5% of the participants believed that GM foods are harmful. The authors of the published paper on the survey added, "In a similar study conducted by Engin et al., the said ratio was 66.7%. Kocak et al. conducted a study among medical faculty students and found that the ratio of those not consuming GMO foods was 54.4%."

In a 2012 survey of 284 registered dietitians, 29.4% of those surveyed believed that "GM foods are completely safe to eat", while 30% disagreed. The survey also determined that the more knowledgeable a dietitian was on GMO, the more likely they were to oppose GMO usage. When given the statement, "Scientists cannot predict future outcomes of genetically modified foods," 60.5% agreed.

In conclusion, Briers' claim of a medical scientists' consensus on GMO safety is false.

Industry bias in favor of GMO safety

Does it matter when GMO safety studies are funded and carried out by industry? Yes, because there is evidence that industry-linked studies are biased in favor of a conclusion of safety:

A review of 94 published studies on health risks and nutritional value of GM crops found that they were much more likely to reach favorable conclusions when the authors were affiliated with the GM industry than when the authors had no industry affiliation. In the studies where there was such a conflict of interest, 100% (41 out of 41) reached a favorable conclusion on GMO safety. The remaining 53 papers, in which none of the authors had professional ties to the biotech industry, were split: 39 concluded safety, 12 found problems, and two had neutral conclusions. This finding suggests that if a study on GMOs involves an industry scientist, it will invariably find no problem with the GMO.

A literature review of GM food safety studies found about an equal number of research groups suggesting that GM foods were safe and groups raising serious concerns. However, the authors commented that most studies concluding that GM foods are as nutritious and safe as non-GM counterparts were performed by the companies responsible for developing the GMO or associates.

A review of 15 published animal feeding studies with glyphosate-tolerant GM crops examined 6 studies by researchers with an industry affiliation and 9 by independent researchers. The review found that all 6 industry studies and 1 independent study found no significant effects from the GM feed; but the remaining 8 independent studies did find significant effects from the GM feed.

GMO risk research funding

Bruers says, “A number of studies indicating risks of GMOs – e.g. those by Gilles-Eric Séralini – were funded by environmental organizations”.

In order to balance the scientific evidence base on GM crops, funding for GMO risk research should be available to independent scientists – but it is notoriously hard to get. Companies and most governments are not motivated to pursue such research. Only one country in the world – Norway – has a research organization that is dedicated to looking at GMO risks. It may be no coincidence that Norway does not have an agribusiness lobby.

While study funding should always be scrutinized for conflicts of interest, there is no greater conflict of interest than the manufacturer/developer of a product sponsoring and controlling the safety research on its own product – which is the situation with GMOs and pesticides. These products are approved on the basis of studies commissioned by the manufacturer. In the case of pesticides, the studies are kept hidden from the public and independent scientists and so cannot be examined.

It is the stated mission of every company to maximize its profits; to do so is its duty to its shareholders. Environmental organizations that sponsor studies also have an interest, normally protection of public health and the environment. Which interest is likely to fatally undermine the veracity of a study – the imperative to sell product, or the desire to protect health and the environment? The answer should be clear.

There are many ways for a company to manipulate a study and its findings in order to show a “false negative” – in other words, to conclude that there is “no effect” even when a toxic effect exists. Methods include: making an animal feeding study duration too short to show long-term effects; making the sample size too small to get statistical significance in findings of harm; choosing an animal known to be insensitive to the substance under test; dismissing statistically significant differences in the test animals as biologically irrelevant, etc. Such shortcomings can produce “false negatives”, when an effect exists but is not found, or is claimed not to be found.

But it is much harder to produce a “false positive”, to come up with a finding that the substance does harm when in fact it is harmless. Yet this is what Bruers appears to suggest could be done by an environmental organization that wanted to skew a study outcome.

It is unclear how (for example) a finding that a substance caused liver or kidney pathologies in a higher number of animals could be invented out of nothing.

Is Bruers alleging that scientists whose research is sponsored by an environmental organization would lie about the number of animals that had that pathology in the various test groups? Does he really believe this, even though the scientists involved in the research are putting their names to the study and publishing it for all to see – and potentially replicate? And even though in many (perhaps most) cases, the pathologist that examines and reports on the disease state of the animal tissues is blinded to whether the tissue is from a control or test group?

Bruers should also ask himself whether any environmental organization would want to risk attaching its name to a fraudulent study by leaning on the researchers to skew the results. What would be its motivation, since the profit motive that leads companies and/or their sponsored researchers to engage in fraudulent science would be absent in this case?

Judy Carman pig study

Bruers attacks Dr. Judy Carman and colleagues’ peer-reviewed experimental study, which found higher rates of severe stomach inflammation and heavier uteri in pigs fed GM feed compared with pigs fed non-GM feed. He does this not by referring to contradictory experimental findings, or even to a peer-reviewed article, but to a blog post attacking the paper, written by the pro-GMO campaigner Mark Lynas. As evidence for his attack on Carman’s paper, Lynas refers to a blog post by the agronomist Andrew Kniss. Lynas praises Kniss for his use of an "appropriate statistical technique".

The editors of the website GMOJudyCarman have replied to Kniss' piece:

"In his blog (weedcontrolfreaks.com), Andrew Kniss professes to know more about statistics than the authors of the paper, even though between them, two of the authors of the paper have 45 years' experience in using and teaching statistics at a university level. They have expertise in agricultural, toxicological, medical and epidemiological statistics."

The editors go on to explain in detail why Kniss has "failed kindergarten-level statistics". This perhaps explains why Kniss has not published his critiques in a peer-reviewed journal.

Lynas believes that Carman should have emphasized the heart and liver abnormalities, which were higher in non-GM-fed pigs than GM-fed pigs. However, they were analyzed by the authors and found not to be statistically significant (the analyses are presented in the paper), which is why they were not discussed.

Are those who question GMO safety equivalent to climate science deniers?

Bruers goes as far as copying Lynas and others in their very misplaced comparison of those who question the safety of GMOs to "the climate deniers who oppose the IPCC and many other scientific bodies." This is a dishonest and inaccurate PR trick.

Corporate lobbyists' attempts to convince the public that manmade climate change isn't happening, and that GMOs are safe, suit their economic agenda but are scientifically indefensible. Generalized claims of GMO safety are "tobacco science" all over again. The main difference between GMO risk research and rigorous climate science is that there is very little funding available for the former.

If someone wishes to argue that the scientists arguing that GMOs have not been proven safe are a mistaken minority, the scientifically valid next step is to read the peer-reviewed studies showing GMO risks (for example, those cited by Krimsky, 2015; Hilbeck and colleagues, 2015; or in the publication, GMO Myths and Truths), and provide a scientific response, based on hard experimental data, to each point of evidence presented.

Ironically, by the way, many climate science deniers are also notable promoters of GMOs, such as the former UK environment minister Owen Paterson [see HERE and HERE] and the pro-corporate lobbyist Patrick Moore [see HERE and HERE].

2. GMOs good for the environment, reduce the use of pesticides?

The second review study cited by Bruers is one by Klümper and Qaim, claiming that GM crop cultivation has led to reduced pesticide use, particularly in Bt crops that produce their own insecticide.

However, these claims were shown to be baseless by a study by Douglas and Tooker (2015). Douglas and Tooker showed that the use of neonicotinoid insecticides on the major US crops subject to GM – corn and soy – expanded dramatically between 2003 and 2011. But Klümper and Qaim's study was blind to this massive increase because the neonicotinoid insecticides were not sprayed onto the growing crop but coated onto the seeds before planting. Klümper and Qaim simply failed to consider insecticidal seed coatings in their calculations. While neonic seed coatings are used on both GM and non-GM seed alike, it makes no sense to claim reductions in insecticide use from GM crops while ignoring this major source of insecticides.

Even without the neonicotinoid factor, Klümper and Qaim omitted the vital consideration that Bt crops do not reduce or eliminate insecticide use, but only change the way in which insecticides are used: from sprayed on, to built-in. The plants themselves are insecticides. The amount of insecticide contained in these GM plants is generally far greater than the amount of chemical insecticide displaced.

GMO proponents often say that this does not matter because Bt toxin is a safe pesticide that has been used for decades by organic and conventional farmers. But this claim falls flat when it is considered that the engineered Bt toxin is different from the natural Bt sprayed by organic and conventional farmers. Many studies have found that GM Bt crops can have toxic effects on non-target organisms, including beneficial insects that help farmers and mammals that eat the crops.

Another problem with Klümper and Qaim's analysis is that it relies heavily on data from the early years of GM crop adoption, before weeds developed resistance to the herbicides sprayed on GM herbicide-tolerant crops and pests developed resistance to the Bt toxins in GM Bt crops. More recent data show that GM crops have increased pesticide use by 7%, compared with the amount that would have been used if the same acres were planted to non-GM crops.

However, that 7% figure is likely to be an underestimate because it doesn't include insecticidal seed treatments. When these are included, the rise in insecticide use since the introduction of GM crops will be far greater, though it is unclear how much of this rise is due to GM crops, as both GM and non-GM seeds are treated.

The neonicotinoid factor throws doubt on whether the Bt toxin trait in GM Bt crops has ever worked at all, as any pest-killing properties seen in the crops could be due to the neonicotinoid seed treatments and not the Bt trait.

WHO verdict on the toxicity of glyphosate

In 2015 the WHO's cancer agency IARC concluded that glyphosate, the main chemical ingredient of the Roundup herbicide that over 80% of GM crops are grown with, is a "probable" carcinogen.

The IARC verdict alone exposes as false Bruers' claim that "the herbicide glyphosate in Roundup is less harmful than many other herbicides used in conventional agriculture". The toxicity of glyphosate and Roundup has long been underestimated. That's largely because:

Pesticides are tested for safety by the companies that manufacture and sell them.

The safety data are kept secret under commercial confidentiality agreements between companies and regulators.

Industry tests on pesticides are carried out, and regulatory safety limits set, on the supposed "active ingredient" alone, not the complete formulations as sold and used, even though the formulations are many times more toxic than the active ingredients.

Industry and regulators largely ignore the large and growing body of scientific evidence published in peer-reviewed journals showing the toxicity of glyphosate and Roundup. Some of this research is collected here and here.

The IARC conclusions should lead to a EU wide ban of glyphosate. Glyphosate is currently being re-assessed for its EU re-approval. This has led to an unseen clash between the anonymous assessors of the German agency Bfr (responsible for the Renewal Assessment Report on glyphosate) and of EFSA on the one hand, and the independent IARC scientists on the other.

In a very straightforward open letter 46 scientists including 9 from the IARC, argue that "the BfR decision is not credible because it is not supported by the evidence and it was not reached in an open and transparent manner" and call the European Commission to "disregard the flawed EFSA finding on glyphosate" and "for a transparent, open and credible review of the scientific literature."

They list several reasons to complain about the EFSA/BfR process:

- "the arguments promoted by the BfR to negate the human, animal and mechanistic evidence are fundamentally and scientifically flawed and should be rejected."

- "We strongly object to the almost non-existent weight given to studies from the literature by the BfR and the strong reliance on non-publicly available data in a limited set of assays that define the minimum data necessary for the approval of a pesticide."

See also CEO's articles on the glyphosate saga:

"The Glyphosate Saga & 'independent scientific advice' according to Germany, the UK & France," by the Corporate Europe Observatory; April 2, 2015

"EFSA and Member States vs. IARC on Glyphosate: Has Science Won?" by the Corporate Europe Observatory; November 25, 2015

3. GM crops do not give higher yields

Bruers claims, "Current GM crops have a 22% higher crop yields than conventional crops and thus a lower land use." His reference for this claim is the meta-analysis by Klümper and Qaim.

Klümper and Qaim qualify their claim of higher yields from GM crops (and confuse the scientific point) by linking it with a claim of reduce cost of production: "There are also plenty of studies showing that GM crops cause benefits in terms of higher yields and cost savings in agricultural production".

Klümper and Qaim then give a number of grouped references, without specifying which reference supports which claim.

This unscientific linkage of two endpoints – yields and production cost – serves to muddy the waters around the question of the performance of GM crops. Higher yields from GM are difficult or impossible to prove, but there is no GM trait for high yield. The scientifically valid way to measure yield is to do side-by-side comparisons of a GM crop and its non-GM (isogenic) parent variety – but such studies are rare.

Some peer-reviewed studies of this type were collected in the Union of Concerned Scientists report, Failure to Yield. The data showed that GM technology has not raised the intrinsic yield of any crop. The intrinsic yields (yield potential of a crop in ideal conditions and before pests and weeds take their toll on the yield) of corn and soybeans rose during the twentieth century, but this was not as a result of GM traits, but due to improvements brought about through traditional breeding.

The study found that GM soybeans did not increase operational yields (yield that remains after pests and weeds have taken their toll on yield), either. GM maize increased operational yields only slightly in years of heavy infestation with the European corn borer pest. GM Bt maize offered little or no advantage when infestation with European corn borer was low to moderate, even when compared with conventional maize not treated with insecticides.

This interpretation of the yield performance of GM crops is shared even by the US Dept. of Agriculture, which is a promoter of GM crops. The USDA says

“Over the first 15 years of commercial use, GE seeds have not been shown to increase yield potentials... In fact, the yields of herbicide-tolerant [HT] or insect-resistant seeds may be occasionally lower than the yields of conventional varieties if the varieties used to carry the HT or Bt genes are not the highest yielding cultivars, as in the earlier years of adoption…”

> [Note: the report can also be accessed here: “Genetically Engineered Crops in the United States,” by Jorge Fernandez-Cornejo, Seth Wechsler, Mike Livingston, and Lorraine Mitchell, USDA; February 2014]

The final phrase of this quote makes clear that yield depends on the background genetics of the non-GM crop into which the GM trait for herbicide tolerance or insect resistance is inserted, not the GM trait itself.

Lower production costs from GMOs?

Regarding Klümper and Qaim’s linked claim about lower production costs of GM crops, the data on relative costs of production are also problematic. They are confused by many variables such as chemical input use, pest pressure in the particular years concerned, subsidies given to farmers for growing certain crops, seed costs (which are often manipulated by seed companies to open up markets for favored products), and irrigation.

A USDA report on the adoption of GM crops in the US gives some idea of the difficulties involved in making claims about the economic performance of GM crops “The profitability of GE seeds for individual farmers depends largely on the value of the yield losses mitigated and the associated pesticide and seed costs… The impacts of GE crop adoption vary by crop and technology. Most studies show that adoption of Bt cotton and Bt corn is associated with increased net returns… However, some studies of Bt corn show that profitability is strongly dependent on pest infestation levels. The impact of HT seeds (for corn, cotton, and soybeans) on net returns depends on many factors.”

By mixing the yield factor with the production cost factor and failing to specify which references support which claim, Klümper and Qaim are confusing the argument.

Klümper and Qaim’s evidence for GMO yields and production costs problematic

An examination of Klümper and Qaim’s references for their linked claims of high yields and low production costs for GMOs raises further serious problems. These papers focus heavily on Bt crops grown on a small scale, whereas over 80% of crops grown worldwide are herbicide-tolerant crops, so Klümper and Qaim’s review does not represent the GMO reality.

Also, crucially, the papers referenced by Klümper and Qaim focus on the early years of GM crop adoption, before herbicide-resistant weeds and Bt toxin-resistant pests undermined the effectiveness of the GM traits.

For example, Pray and colleagues (2002) focus on the early years of Bt cotton in China – 1999–2001 – before secondary pests (pests not targeted by the Bt toxins in the crop) moved in on Bt cotton. Even so, Pray's claimed benefits for Bt cotton are unspectacular: yields for Bt cotton were between 5 and 10% higher than non-Bt. However, these were not side-by-side comparisons, where the GM crop is compared with the non-GM parent variety and grown in the same conditions. Thus yield gains, as pointed out by Prof Glenn Stone, may be due to non-GM trait-related factors such as "early adopter" syndrome (the best farmers tend to be the first to adopt new seeds) or the exceptional care that farmers devote to novel and expensive seeds.

In Pray and colleagues' paper, costs of Bt cotton production were variable – less than non-Bt cotton in 1999 and 2001 but slightly higher in 2000. In a region where bollworm (the pest that Bt toxin targets) was not a problem, the authors state, "the economic benefits from Bt are not great – especially at the higher prices of Bt seed in this region".

It is important to follow a new technology such as GM Bt crops for several years before claiming it as a success. A later study, published in 2012, documented emerging bollworm resistance to Bt cotton. And at the time of writing this article, Indian farmers have taken to the streets in protest at the widespread failure of Bt cotton in the Punjab region. Between half and two-thirds of the crop has fallen victim to whitefly attack, an example of a secondary pest problem.

Another reference given by Klümper and Qaim to back their claims of yield gains and reduced production costs for GM crops is a paper by Huang and colleagues (2008), on Bt rice in China in the years 2002–4. Again these are the early years of this crop, which has not been commercialized and so is not relevant to a discussion of the performance of commercialized GM crops. And the authors' conclusions are hardly an endorsement for GM crops. They conclude, "There is at most only a small (if any) increase in yields" from Bt rice over non-GM rice, and add, "The absence of yield effects should not be surprising. A report by the Food and Agricultural Organization (FAO 2004) reported that yields usually do not rise after the adoption of Bt crops." The authors also question "whether the nation needs any more rice or not", as rice consumption has fallen in China.

Taken together, these studies do not support Klümper and Qaim's claims of yield gains and reduced production costs for GM crops. Those claims appear to rely on readers of Klümper and Qaim's paper failing to check the references for themselves.

Outdated data from Argentina used

Another reference given by Klümper and Qaim to back their claims of yield gains and reduced production costs for GM crops is Qaim and Traxler (2005). These authors reported a slight decrease in yield of GM Roundup Ready soybeans in comparison with non-GM soybeans. Cost savings were greater with GM soybeans. However, this was before herbicide-resistant weeds became a major problem in Argentina.

A later (2008) study noted that the spread of glyphosate-resistant weeds in soybean fields in Argentina and Brazil is "of major concern" and called glyphosate-resistant Johnsongrass "a major threat to glyphosate-resistant soybean productivity in northern fields of Argentina". Farmers will try to manage glyphosate-resistant weeds by applying more and different herbicides, but this will raise the cost of production. This issue is not considered by Klümper and Qaim.

Failed GMO project in Africa used to hype GMOs

The most extraordinary reference given by Klümper and Qaim in support of favorable GMO yield and production costs is Morse and colleagues (2004). This paper focuses on Bt cotton in Makhathini, South Africa, between 1998 and 2001 – the first years of this project. Based on these early years, Morse states, "Bt cotton adopters achieved consistently higher yields and revenue per hectare than non-adopters over the three seasons".

But had the authors followed the project for longer, they would have been forced to admit to very different conclusions. That's because after its peak in 2001, the project rapidly went into steep decline and is now widely seen as a GMO crop failure.

The Makhathini project failed due to adverse weather conditions and farmer indebtedness. A 2003 report* calculated that crop failures left the farmers who had bought expensive Bt cotton seeds with debts of $1.2 million. Pest attacks on the crop had forced farmers into buying costly insecticide prays. A 2006 study* concluded that the Makhathini project did not generate sufficient income to generate a "tangible and sustainable socioeconomic improvement".

> [*The link in the original post is broken; it may be this: "Impact of Bt cotton adoption on pesticide use by smallholders: A 2-year survey in Makhatini Flats (South Africa)," by Jean-Luc Hofs, Michel Fok & Maurice Vaissayre, Crop Protection, Vol. 25; 2006]

A 2012 review reported that by the 2010–2011 growing season, the number of farmers growing GM Bt cotton had shrunk by 90% from the number during the period of Bt cotton's claimed success (1998–2000). Yields continued to vary widely according to rainfall levels, hovering within 10% of what they were before Bt cotton was introduced. Overall pest control costs remained significantly higher with Bt cotton (65% of total input costs) than with non-Bt cotton (42% of total input costs).

The review concluded that the main value of Makhathini project appears to have been as a public relations exercise for GMO proponents, providing “crucial ammunition to help convince other African nations to adopt GM crops”. The author added that there was a “disconnect” between how the project was represented and “the realities faced by its cotton growers”.

Given how the Makhathini project panned out, it is astonishing that Klümper and Qaim included these data in their review.

Increased profits claim based on outdated data

Klümper and Qaim’s meta-analysis is also Bruers’ source for the claim that farmers have increased their profits by 68% by growing GM crops. The sources for this claim are the early and outdated data cited above. But the reduced weed and insect pest control inputs that previously enabled savings in production costs can no longer be assumed to apply. Therefore the claim of 68% increased profits is not reliable.

Klümper and Qaim should explain why they failed to obtain up-to-date data that take into consideration the serious problems that have emerged with GMOs over several years of planting and which are reported to be impacting yield and performance.

Realistic picture of Bt cotton yields in India

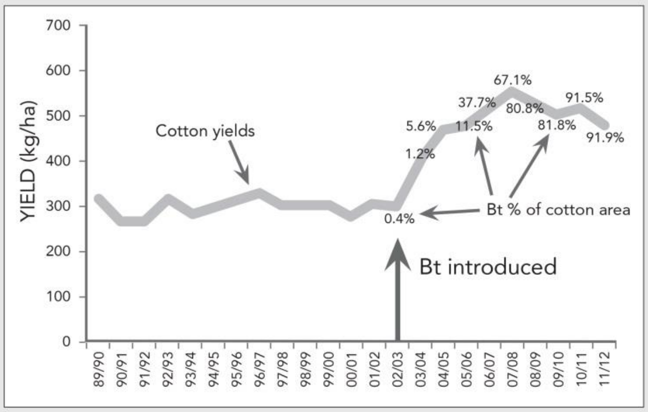
Since the introduction of GM Bt cotton into India, there has been a fierce debate about its performance. Some claim it has delivered higher yields and improved farmer income, while others claim it has suffered widespread failure and led to farmer suicides. The main difficulty in resolving the argument is that good comparative data on Bt and non-Bt cotton performance do not exist. Typically such data would be generated from a study in which two groups of farmers matched for ability and farm conditions would be assigned to grow Bt cotton or non-Bt cotton.

Some of the most nuanced analyses of the performance of Bt cotton are by the US academic Glenn Davis Stone, who mistrusts “narratives” regarding Bt cotton from both sides of the debate. According to Stone, within five years of the introduction of Bt cotton in India, national cotton yields rose by 84%. However, almost all of that rise occurred in 2003/4, when only 1.2% of the cotton was Bt, and 2004/5, when only 5.6% of the cotton was Bt. In short, Stone concluded, “Bt couldn’t have been responsible for the rise.”

What is more, wrote Stone in 2012, “In the last four years, as Bt has risen from 67% to 92% of India’s cotton, yields have dropped steadily.” According to India’s Cotton Advisory Board, yield declined to a five-year low in 2012–13.

Stone summed up the situation as follows: “Bt didn’t explain the big rise in yields, and since Bt has taken over, yields have been steadily worsening.”

All India cotton yields and Bt percentage of cotton area



India approved Bt cotton in 2002; in 2012 it accounted for 92% of all Indian cotton. Average nationwide cotton yields went from 302 kg/ha in the 2002/3 season to a projected 481 kg/ha in 2011/12 – up 59.3% overall. This chart shows the trends in yields, which took off after Bt was introduced in 2002.

The problem is that while yields did take off right after Bt cotton was approved, this was well before Bt cotton was widely adopted. This graph shows the yearly percentages of all Indian cotton land planted to Bt cotton. Most of the yield increase happened between 2002–2005, when Bt only comprised between 0.4-5.6% of India’s cotton. Obviously Bt couldn’t have accounted for more than a tiny speck of the national rise.

Charts and data adapted from Glenn Davis Stone, “Bt cotton, remarkable success, and four ugly facts”, fieldquestions, 12 February 2012. http://fieldquestions.com/2012/02/12/bt-cotton-remarkable-success-and-four-ugly-facts/

Yield data is from India’s Cotton Advisory Board, downloaded 28 Jan 2012 from the website of the Cotton Corporation of India Ltd (http://cotcorp.gov.in/state-operations.aspx): “State-wise area, production, yield for last ten years”. Bt cotton adoption data is from ISAAA.

These facts are illustrated in the graphic [to the left].

So what explained the temporary rise in yields in the early 2000s, if it wasn’t Bt cotton? Dr. Keshav Kranthi, director of India’s Central Institute for Cotton Research, believes that the other factor responsible for the short-term yield gains was the use of insecticides against sap-sucking pests such as the leaf hopper.

Dr. Kranthi wrote, “Since 2002, every Bt cotton seed has been treated with the highly effective insecticide, imidacloprid.” This insecticide also could also have accounted for the recent decline in cotton yield, since “Recently, leaf hoppers were found to have developed resistance to imidacloprid and… yields are likely to decline.”

Research from the University of Hannover, Germany, in cooperation with the Food and Agriculture Organization of the United Nations, found that Bt cotton performed better under irrigated conditions but that non-Bt local varieties were better suited to rainfed conditions. Most cotton production in India is rainfed. Moreover, the yield advantage of Bt cotton under irrigation was offset by higher production costs and lower product prices.

Realistic study about GMO yields in the USA

A more realistic picture of yields for the widely grown GM crops in the USA and Canada emerges from a study published in 2013 by Heinemann and colleagues. The study looked at 50 years' worth of data from North America and Europe, before and after GM crops were introduced in the US. It focused on maize, rapeseed, soybeans, wheat, and cotton. All these crops except for wheat have been subject to GM in the US and Canada. The researchers looked at comparative yields between North America and Europe, for those crops that have been subject to GM in North America. They found that since GMOs were introduced in the US and Canada in the mid-1990s, yields for Europe's largely non-GM production have been marginally higher than yields for North America's largely GM production. And Europe has achieved these higher yields with less pesticide use than the US.

The data show that contrary to claims by GMO proponents, Europe is not being left behind due to turning its back on GMOs, but that the opposite is true: North America's dependence on GMO crops may be holding back progress on yields and chemical use.

4. GMOs encourage superweeds

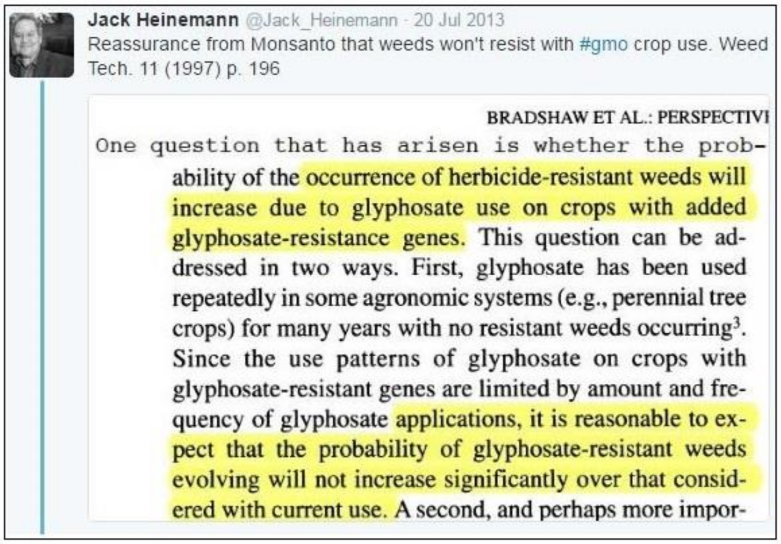
Bruers says, "There is no good evidence of GMO cultivation resulting more quickly in superweeds than in conventional farming. Even before the advent of glyphosate-tolerant GM crops, weeds emerged that are resistant to glyphosate."

This is disingenuous. Herbicide-resistant weeds were known before GM crops were introduced – but the odd resistant weed inhabiting a ditch or bog isn't the same as vast populations of herbicide-resistant weeds spreading over GMO crop fields and crowding out the maize or soy that's supposed to be thriving there.

The former doesn't matter to farmers, whereas the latter phenomenon is impacting US agriculture to a "severe" degree. It's estimated that 60 million acres of US farmland are now infested with resistant weeds. A study by David Mortensen, a plant ecologist at Pennsylvania State University, predicts that total herbicide use in the US will rise from around 1.5 kilograms per hectare in 2013 to more than 3.5 kilograms per hectare in 2025 as a direct result of GM crop use encouraging resistant weeds.

Bruers frames herbicide-resistant superweeds as a problem of modern farming and as not related to GMOs. However, GMO crops are designed to survive high doses of herbicide that would kill a non-GMO crop. This higher use of herbicides with GMO crops causes intense selection pressure. The result is large populations of resistant weeds in and around crop fields, which leads to farmers having to spray more, and different, herbicides to control weeds. The result is what plant ecologist David Mortensen calls "an accelerating transgene-facilitated herbicide treadmill, which has significant agronomic and environmental-quality implications". In other words, this is a GMO-related problem.

And while we've had chemically-based agriculture since the 1950s, glyphosate-resistant superweeds have only been a problem since glyphosate-tolerant GM crops were grown on a large scale. This is confirmed by Monsanto's own statement from 1997, when GM crops had only been introduced for one year. Monsanto scientists said that even though glyphosate had been used in some farming systems for many years, "no resistant weeds" had occurred. They added that the introduction of GM glyphosate-tolerant crops would not increase the "probability" of resistant weeds.


Jack Heinemann @Jack_Heinemann · 20 Jul 2013
Reassurance from Monsanto that weeds won't resist with #gmo crop use. Weed Tech. 11 (1997) p. 196

BRADSHAW ET AL.: PERSPECTIVI

One question that has arisen is whether the probability of the occurrence of herbicide-resistant weeds will increase due to glyphosate use on crops with added glyphosate-resistance genes. This question can be addressed in two ways. First, glyphosate has been used repeatedly in some agronomic systems (e.g., perennial tree crops) for many years with no resistant weeds occurring[3]. Since the use patterns of glyphosate on crops with glyphosate-resistant genes are limited by amount and frequency of glyphosate applications, it is reasonable to expect that the probability of glyphosate-resistant weeds evolving will not increase significantly over that considered with current use. A second, and perhaps more impor-

In addition, Monsanto told the EU pesticide regulatory authorities in 1999, in support of its application for the authorization of glyphosate, that it had "thoroughly" investigated all instances of resistant weeds and found only one, a ryegrass in Australia, present in only two locations, which was being "easily controlled" (see page 12 of the physical pdf in this document). Clearly, according to Monsanto's own statements and investigations, glyphosate-resistant weeds were not a problem prior to the introduction of GM crops, and now they are.

5. Non-GMO herbicide-tolerant crops: another problem

Bruers is correct that non-GM herbicide-tolerant crops exist, so the problems caused by herbicide-tolerant crops are not entirely confined to GMOs – though practically speaking, the acreage planted to non-GM herbicide-tolerant crops is likely to be tiny compared with the GMO acreage. Just like GM herbicide-tolerant crops, non-GM herbicide-tolerant crops enable the crop to survive being sprayed with herbicide. And just like GM herbicide-tolerant crops, they pose risks* to the environment resulting from increased herbicide sprays and risks to consumers associated with ingesting toxic herbicide residues.

> [*The link has changed since the article was first published. The new link to this study is here: "Milkweed loss in agricultural fields because of herbicide use: effect on the monarch butterfly population," by John Pleasansts and Karen Oberhauser, Insect Conservation and Diversity, Vol. 6; March 12, 2012 (10 pages)]

For these reasons, many environmental groups oppose herbicide-tolerant crops of both GM and non-GM varieties and believe that both should be strictly regulated according to the specific risks they pose. The existence of herbicide-tolerant traits in both GM and non-GM crops also confirm environmentalists' contention that GM is just an extension of chemical-intensive agriculture, not a sustainable alternative to it.

Where GM herbicide-tolerant crops differ from non-GM herbicide-tolerant crops is that the GM crops carry the additional risk of the disruptions to the plant genome resulting from the genetic engineering process. These disruptions can lead to the plant being toxic or allergenic, or to having altered nutritional value.

6. GM crops have a negative impact on biodiversity

Bruers claims that GM crops have "No higher impact on biodiversity" than conventional farming. He states, "Some reviews compare the impact on biodiversity (at the level of the crop, the farm and the countryside) between GMO farming and conventional farming and come to the conclusion that GMOs are likely to have a lower impact on biodiversity."

The review that Bruers cites to back up this statement was sponsored by industry lobby group CropLife International and was authored by Janet E. Carpenter, a consultant to the GMO industry.

This conflict of interest would be of secondary importance if the information contained in the review were reliable. But the paper was published in 2011, before crucial experiments were carried out that show claims made in it to be invalid.

Carpenter (Box 2) criticizes experimental studies finding toxic effects of toxins derived from GM Bt crops on beneficial and non-target invertebrates like ladybirds and lacewings. Carpenter favors rebuttal studies that claimed to show that the original findings of toxicity in ladybirds and lacewings were false positives due to methodological flaws and bad study design.

However, subsequent experimental studies by the authors of the criticized studies, Hilbeck and colleagues, revealed that it is the rebuttal studies that were fatally flawed. Hilbeck and colleagues demonstrated that inadequate testing

Box 2. The importance of study design. There are several examples of study design leading to unwarranted conclusions on the impact of Bt crops on non-target above-ground invertebrates. **Monarch Butterfly:** Following an initial report of toxic effects of Bt corn pollen to Monarch butterfly larvae that was based on a no-choice laboratory feeding study,[61] numerous additional studies have been conducted, including both laboratory and field studies. Naranjo's analysis of the potential impact of Bt crops on non-target herbivore species was dominated by studies on the monarch butterfly, showing significant impacts in laboratory studies, but no impact in field studies.[48] This finding mirrors an earlier analysis of the impact on monarch butterflies, based on a collaborative research effort by scientists from several US states and Canada, which showed that risks in the field were negligible.[62] Green Lacewing: In a study by Dutton et al. the potential tritrophic effects of Cry1Ab-expressing Bt corn on green lacewing were studied in reference 63. Three different prey organisms were fed Bt or non-Bt corn leaves and were then fed to lacewing larvae. Lacewing larvae that fed on Bt-susceptible leafworms had significantly higher mortality and development time than those in the control treatment. These findings led to further research to explain the results. A follow-up study confirmed that the protein was transferred from prey to predator, and the biological activity of the Bt protein, for two of three prey organisms, spider mites and leafworms.[64] The concentrations of Cry1Ab was much higher in the spider mites, which had no effect on lacewing larvae. These additional experiments led researchers to believe that the effects of the Bt-fed leafworms were due to low quality pretty, since leafworms are susceptible to Cry1Ab protein.[65] **Caddisflies:** A 2007 paper suggested that Bt maize affects caddisflies.[66] In that study, two caddisfly species were fed either pollen or leaves from Bt and non-Bt corn in groundwater or streamwater. For one caddisfly species, Helicopsyche borealis, the higher tested concentration of Bt corn pollen was associated with increased mortality. The other species, Lepidostoma liba had greater than 50% lower frother rates when fed Bt corn littler compared with non-Bt corn litter, although mortality was not different. The Rosi-Marshall study has been criticized for not using appropriate controls.[67] Specifically, the study did not use non-Bt near isolines as the comparator, and therefore may have led to erroneous conclusions based on other factors that differ between corn hybrids. Further, no quantification of the Bt protein, or other chemical parameters in tested groundwater or streamwater was provided. As the level of Bt expression in pollen is quite low, the observed effects may have been due to other factors.[68] **Ladybird Beetle:** The results of 2009 paper that showed mortality to ladybird beetle at an intermediate tested concentration[69] have been questioned based on methodological flaws and inconsistencies.[70] The criticism cites a lack of quantification of exposure and unexplained high variability in mortality for control groups. In addition, the results contradict classical dose-response models, as mortality was lower at the highest tested concentration than at the intermediate concentration. The study also contradicts established findings that susceptible organisms suffer from sub-lethal effects long before direct toxic effects can be observed.

protocols were the underlying reasons for failing to find the same results in the rebuttal studies for both non-target organisms – lacewings and ladybirds.

For example, Hilbeck and colleagues showed that the lacewings in the rebuttal study could not have ingested the tested GM Bt toxins in the form provided by the researchers, coated onto moth eggs, as their mouthparts are formed in such a way as to make ingestion impossible. This is equivalent to testing an orally administered drug for side-effects by applying it to the skin, ensuring that none of the human subjects actually swallows the drug.

This scientific debate was high-profile and took place in the peer-reviewed literature. It is summarized, with references, in GMO Myths and Truths.

Hilbeck and colleagues' recent studies confirming the toxic effects of Bt crops and pollen have not been scientifically refuted. Mostly, they are simply ignored by GMO proponents.

Bruers' use of outdated and discredited experimental evidence to claim safety of GM crops is scientifically indefensible.

Non-target invertebrates on GM Bt crops

Bruers also claims, "A meta-analysis in the top journal Science found that on fields with insect-resistant GM crops (Bt crops), more harmless invertebrates (e.g. insects and spiders) are found than on the fields where insecticide is sprayed."

Bruers' cited source is Marvier and colleagues (2007), "A meta-analysis of effects of Bt cotton and maize on nontarget invertebrates". Bruers chooses to look at the meta-analysis's comparison of two unsustainable farming systems: GM Bt maize and non-GM maize where insecticides were sprayed. The review did indeed find, as Bruers notes, that when non-GM fields were sprayed with insecticides, there was a generally higher invertebrate abundance in the GM Bt maize fields.

But what Bruers omits to mention is that the meta-analysis also included a comparison that is much more interesting to proponents of sustainable agriculture: between GM Bt maize fields and non-GM maize unsprayed with insecticides. In this case, the invertebrate abundance was higher in the unsprayed non-GM maize.

This shows that opposite conclusions on the effects of GM Bt maize and biodiversity can be reached from the same evidence base, depending on which comparator is used. While GM crops may look superficially good for biodiversity when the comparator is insecticide-sprayed maize, they appear bad for biodiversity when the comparator is an unsprayed field.

One lesson that can be drawn from this study is that deciding which questions to address in scientific research should not left to scientists alone, and certainly not to biotech and agrochemical multinationals. This role belongs to society as a whole, based on its environmental protection and food production goals.

Those who argue that avoiding insecticide use on maize crops would be a farming disaster are ignoring history. Prior to the advent of GM Bt maize, according to Dr. Doug Gurian-Sherman, a former biotech specialist at the US EPA and then a senior scientist at the Union of Concerned Scientists, very little maize was sprayed with insecticide, with only 5-10% of all maize being treated for corn borers.

Unsupported claim about GM Bt crops' specificity to pests

Bruers claims, "GM Bt crops produce their own insecticide, so mainly the harmful insects that eat the crop are affected. When Bt insecticide is sprayed onto crops [by organic and conventional farmers], many more insect species are affected, including insects which are not harmful."

Bruers provides no evidence to back his claims that GM Bt crops are less harmful to non-target insects than the natural Bt soil bacterium which is sprayed as a biological insecticide by organic and conventional farmers. However, many peer-reviewed studies show toxic effects of Bt crops and pollen on beneficial and non-target organisms, including on mammals in feeding studies with Bt crops.

Claims that natural Bt sprays are more harmful to non-target insects than GM Bt crops are questionable. Natural Bt is not a toxin but a protoxin or toxin precursor. It is only converted into a toxin when ingested by the insect that eats it. It is sprayed only when needed and in a targeted manner, to avoid pest resistance building up. Sprayed Bt breaks down rapidly in daylight. The Bt toxins in GM Bt crops, in contrast, are pre-activated toxins present in every cell of the GM Bt plants. They are 'turned on' all the time and thus pests are exposed 24/7. This is a recipe for the rapid evolution of pest resistance, which has occurred with GM Bt crops, exactly as predicted by scientists and environmentalists.

The engineered Bt toxin protein is different in structure and mode of action from the natural Bt used in sprays, meaning it can have different biological and toxicological properties* and can lose its specificity to certain insect pests. Moreover, the mode of action of Bt toxin is not fully understood *

> [*Note: the original link does not work, however this may be the publication that is cited: "Another View on Bt Proteins - How Specific are they and What Else Might They Do?" by Angelika Hilbeck & J. Schmidt, Biopesticides International, Vol. 2, No. 1; January 2006 (50 pages)]

Thus Bruers' claims of the safety and specificity of GM Bt crops are not scientifically justified.

GM herbicide-tolerant crops and biodiversity

Shifting the focus from GM Bt crops to GM herbicide-tolerant crops, which represent over 80% of all GM crops grown worldwide, Bruers' claim that "GMOs are likely to have a lower impact on biodiversity" is once again refuted by the evidence.

The UK government-funded Farm Scale Evaluations (FSEs) looked at the effects on farmland wildlife of the cultivation of four GM herbicide-tolerant crops, compared with non-GM crops grown under intensive chemically-based management.

The results for sugar beet and oilseed rape showed that GM herbicide-tolerant crop management reduced weeds and weed seeds and therefore would damage farmland wildlife.

For maize the results showed GM crop management to be better for wildlife than conventional chemically intensive management. However, the conventional weed control used the toxic herbicide atrazine, which was banned in Europe before the FSE results were published.

The outcome of the FSEs was that all but one of the GM crops tested was worse for biodiversity than non-GM crops grown under intensive chemically-based management. No GM crops were subsequently commercially planted in the UK.

7. Does GM enable environmentally friendly no-till farming to be practiced?

Bruers claims that GMO farming is better for biodiversity than conventional chemical farming because it enables a "lower level of tillage (ploughing). Herbicide-tolerant crops make it possible to avoid unwanted plants without the need to plough the soil."

However, GM crops are not necessary for no-till and low-till agriculture. No-till and low-till are practiced in both non-GM conventional and organic farming. Cover crops are a common alternative to tillage in such systems.

In fact, the majority of no-till adoption had already taken place before 1996, the year GM crops first came onto the market, according to US Dept. of Agriculture data.*

The USDA report* says that adoption of no-till and low-till for soybeans grew from 25% of the soybean acreage in 1990 to 48% in 1995, the 5-year period previous to the introduction of GM herbicide-tolerant soybeans. Growth of no-till and low-till increased further in 1996, the year herbicide-tolerant soybeans were introduced, but then stagnated to 50–60% in the following years.

> [*Note: this link also recently changed since this article was originally published; the report that matches the citation is most likely "Pesticide Use in U.S. Agriculture: 21 Selected Crops, 1960-2008," by Jorge Fernandez-Cornejo et al, USDA; May 2014]

Biotechnology expert Dr. Doug Gurian-Sherman, then of the Union of Concerned Scientists, commented on the findings: "Roundup Ready crops have made no-till easier, but so have no-till seed drills, and Farm Bill incentives that went into effect in 1986. If you actually look at the additional adoption of no-till after 1996, it is only a few per cent in corn, almost nothing in cotton, and a little more in soy (maybe 5 to 10% of acres). So contrary to the widespread myth, the data do not support a major role of GM crops in the increase in no-till over the past few decades."

Environmental impacts of no-till with herbicide-tolerant GMOs

Bruers says: "The ploughing of the soil (a common practice in conventional and organic farming) is not good for the environment because it leads to less storage of CO2 in the soil (less buffer against global warming), increased use of fuels for machinery, soil erosion, more leaching of nutrients and chemicals (i.e. more eutrophication and toxic substances in rivers) and more disturbance of the soil."

General claims of environmental benefits for GM herbicide-tolerant crops with no-till cultivation are misleading. One study compared the environmental impacts of growing GM Roundup Ready and non-GM soy, using an indicator called Environmental Impact Quotient (EIQ). EIQ assesses the negative environmental impacts of the use of pesticides and herbicides on farm workers, consumers and ecology (fish, birds, bees and other beneficial insects).

The study found that in Argentina, the negative environmental impact of GM soy was higher than that of non-GM soy, in both no-till and tillage systems, because of the herbicides used. These are broad-spectrum in nature – that is, they kill all plants except GM plants engineered to tolerate them. Also, the adoption of no-till raised the EIQ, whether the soy was GM Roundup Ready or non-GM. The main reason for the increase in herbicides used in no-till systems was the spread of glyphosate-resistant superweeds.

No-till doesn't store more carbon

Contrary to Bruers' claim, no-till farming does not store (sequester) more carbon in the soil.

Mortensen and colleagues found, "Greater soil carbon and nitrogen were observed in integrated systems that used tillage, cover crops, and manure than in a conventionally managed no-till system, regardless of whether cover crops were used in the no-till system."

A comprehensive review* of the scientific literature found that no-till fields stored no more carbon than ploughed fields when carbon storage at soil depths greater than 30 cm was taken into account. Studies claiming to find carbon storage benefits from no-till only measure carbon storage down to a depth of about 30 cm and so do not give an accurate picture.

> [*The link in the original publication is no longer valid; it may originally have been linked to this: "Limited potential of no-till agriculture for climate change mitigation," by David S. Powlson, Clare M. Stirling, M. L. Jat, Bruno G. Gerard, Cheryl A. Palm, Pedro A. Sanchez & Kenneth G. Cassman, Nature Climate Change, Vol. 4; July 2014; a related publication is here: "Tillage and soil carbon sequestration -What do we really know?" by John M. Baker, Tyson E. Ochsner, Rodney T. Venterea & Timothy J. Griffis, Agriculture, Ecosystems and Environment, Vol. 118; 2007]

On the other hand, organic and agroecological methods probably do increase soil carbon storage.

Finally, it is questionable how much of the area planted to GM herbicide-tolerant crops is still managed under no-till or low-till systems. The spread of herbicide-resistant superweeds has undermined the GM no-till or low-till model of farming, forcing farmers back to ploughing and pulling weeds by hand. It is not valid to assume that farmers who plant GM herbicide-tolerant crops are not ploughing, without actual evidence.

8. Trustworthy studies and animal experiments

Bruers says, "It is distressing to see that many environmental organizations refer to untrustworthy studies and unethical animal experimentation to put the health of GMOs in question".

If he wishes to argue that studies finding risk or harm from GMOs are intrinsically less reliable than studies finding safety, he will need to:

- decide on his criteria for reliability
- apply those criteria to both classes of study in an even-handed manner

- Present his comparative analysis of both these classes of study and prove his hypothesis that studies finding risk or harm from GMOs are less reliable.

This method was followed in a peer-reviewed study analyzing the European Food Safety Authority's critique of the Séralini study, which found toxic effects in animals fed GM maize and tiny amounts of Roundup. The authors took EFSA's criteria for rejecting the Séralini study and applied them even-handedly to the Séralini study and to publications by Monsanto alleging safety for the GM maize. The analysis found that all of the studies satisfied or failed to satisfy EFSA's criteria to a comparable extent and that therefore EFSA's rejection of the Séralini study and acceptance of the Monsanto studies at face value were not scientifically justified.

Bruers is welcome to write and publish his own similar analysis in a peer-reviewed journal. A well-researched article on this topic would be a service to the public and to science.

Is it unethical to feed experimental animals GMOs and pesticide residues?

If someone wishes to argue that it is unethical to feed experimental animals realistic doses of GMOs and pesticides (such as humans and livestock animals will be exposed to in the event of commercialization), then s/he should answer the question: How can it therefore be ethical to feed the same substances to humans and livestock animals?

This problem will exist as long as companies are allowed to place toxic and potentially toxic substances into the food and feed supplies. In vitro methods are not yet ready to replace animal experiments.

9. 'Natural' genetic engineering?

Bruers says, "Horizontal gene transfer such as genetic engineering is not unnatural, because in nature it also happens through viruses. Thus there is evidence that we humans have more than 140 genes derived from other species (such as algae, fungi and bacteria) and we probably acquired them by horizontal gene transfer."

Viral infection leading to horizontal gene transfer (HGT) doesn't prove that genetic engineering is safe – quite the reverse. Viral infection can be and often is a pathogenic (disease-causing) process. We do not know what damage these infection and HGT events caused in the past. All we know is that we are descended from the survivors of any damage that might have been caused by such events.

Scientists have long known that horizontal gene transfer (HGT) happens in nature – but that's no reason to do it to our food crops at breakneck speed. HGT happens in nature across evolutionary timescales; the results have been selected to be benign or harmless. Humans and their crop plants have co-evolved over long periods. We and our crops are survivors of such HGT events. Those crops that caused damage, and the humans that were damaged, would have been 'discarded' during long evolutionary processes. A crop variety that made men infertile, for example, would have been selected out because the people who were eating that crop would not have thrived and bred.

Thus "natural" HGT and viral infections are no reason to assume that the rapid, numerous, and radical changes made in the laboratory to genetically engineer crop plants will be safe.

Prof Jack Heinemann and Dr. Michael Hansen explain this in more detail here.

10. Mycotoxins and toxic celery

Bruers says, "There are indications that some GMOs can provide health benefits. Bt maize would have lower concentrations of carcinogenic mycotoxins in comparison with conventional maize. GMOs are tested for health, and health tests can always be better. But conventionally bred crops are not tested so heavily. For example, toxic Lenape potato and celery entered the market, and were both products of conventional breeding."

In stating, "There are indications that some GMOs can provide health benefits", Bruers is referring to limited and outdated evidence that Bt maize can contain lower levels of mycotoxins because in the early days of commercialization, Bt maize often had less insect infestation and thus there were fewer holes in the maize for mycotoxins to proliferate in. Now that Bt maize has lost resistance to many pests, these studies should be re-done. The comparator should include maize grown under Integrated Pest Management and organic systems, since there are many ways of controlling pests and these should be fairly evaluated. Storage conditions also have a major influence on mycotoxin content, so these should be considered in any attempt to reduce mycotoxins in food and feed crops.

It is well known that conventional breeding has on occasion produced a toxic variety of a crop. However, the crucial difference between these varieties and GMOs are that with conventionally bred crops, responsible breeders know what to look for. They look for elevated levels of toxins that are already in the plant but normally remain at safe levels. Genetic modification, on the other hand, can give rise to unexpected new toxins or allergens that will not be looked for precisely because they are unexpected.

In every animal feeding study that has found toxic effects from the GM crop, those effects were unexpected. The researchers still do not know why they occurred (i.e. which particular unexpected toxin was responsible) because no experiment finding a problem with a GMO has been followed up.

11. Can GMOs reduce food waste?

Bruers says, "One can try to develop GMOs that spoil less quickly. By improved shelf life may contribute to GMOs to a reduction in food waste."

Bruers is entitled to fantasize, but a fantasy is all this is. And even if genetic engineers were able to come up with a GMO that maintains a cosmetic appearance of freshness while (inevitably) losing many of the nutrients that give food its health-promoting qualities, would consumers want it?

Some more practical suggestions to reduce the amount of food wasted – which totals up to 50% – from the Institution of Mechanical Engineers are here*

> [The link in the original publication no is no longer valid; however this is most likely the intended link with three other links on the website which are also relevant:
>
> "New report: as much as 2 billion tons of all food produced ends up as waste," by the Institution of Mechanical Engineers; January 10, 2013
>
> > "Institution's latest report sparks debate on food waste around the world," by the Institution of Mechanical Engineers; January 30, 2013
> >
> > "Global Food: Waste Not, Want Not," by the Institution of Mechanical Engineers; November 2, 2013
> >
> > "Global Food: Waste Not, Want Not," by the Institution of Mechanical Engineers; January 2013 (36 pages)]

Annex I

"Big Lists of Studies" do not show GMO safety

Three "Big Lists of Studies" are regularly cited as evidence of GMO safety for consumption. Bruers relies on two of them.

The first is the Nicolia review, which is addressed in point 2) above. This review does not show GMO safety; it includes many irrelevant studies; it omits important studies; and some of the studies included in the references and/or supplementary materials actually show risks or toxic effects from GMOs, which the review authors omit to mention or misrepresent in their published paper.

The second "Big List" is the GENERA database of studies, collected by a group of GMO proponents called Biology Fortified, or Biofortified.

Several of Biofortified's experts have recently been exposed by emails released in freedom of information requests as working with the GMO and pesticide industry to defend and promote their products.

This conflict of interest in itself would not discredit the GENERA database. However, Biofortified's claim - repeated by Bruers - that its database shows that "half of GMO research is independent" - has been discredited in an analysis by Tim Schwab of Food & Water Watch.

Schwab points out that:

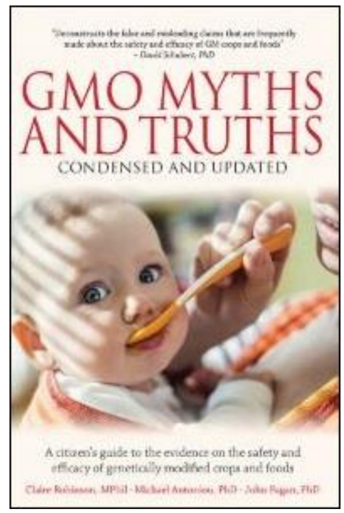
- The database contains only a fraction of the GMO research available.
- 83 of the 400 studies in the database do not disclose a funding source.
- Biofortified doesn't consider the impact of industry authorship on independence. For example, if the pro-GMO Gates Foundation funds a study that is authored by a Monsanto scientist, Biofortified thinks it's "independent".
- Biofortified mislabels funders as being independent when they are not.
- Biofortified mislabels government agencies that actively promote GMOs, such as the USDA, as independent.
- The biggest funders of studies in the database are the USDA and Monsanto – neither of which are independent.

In addition, the GENERA database suffers from the same limitations and problems as the Nicolia review, namely:

- It contains many animal production studies which are too short in duration to give information about any health effects beyond acute toxicity.
- It contains many studies, such as animal production studies, which do not investigate health effects in detail.
- It contains many studies using animal models such as broiler chickens that are not relevant to human or mammal health.

- It contains studies that find toxic effects from GMOs, such as Pusztai's study on GM potatoes. So it cannot be claimed that the studies in GENERA collectively show that GMOs are safe.

The third Big List of Studies, which Bruers does not mention – but numerous other GMO proponents do, such as Jon Entine - is a review co-authored by former Monsanto scientist Van Eenennaam. The review's conclusions are refuted here.



Source: "GM crops: rebuttal of claims on safety and benefits," by Claire Robinson, Corporate Europe Observatory; June 13, 2016

Claire Robinson, MPhil, is an editor at GMWatch, which is "an independent organization that seeks to counter the enormous corporate political power and propaganda of the GMO industry and its supporters." Claire is also a co-author of the report GMO Myths and Truths, 2nd edition as well as the third edition in smaller, condensed book.

Corporate Europe Observatory https://corporateeurope.org/

*This format was published on October 30, 2016 by Jeff Kirkpatrick, Ban GMOs Now.

Please note that some links were no longer valid in the original publication by Corporate Europe Observatory. I have attempted to replace all those links with working links to the correct websites; in one or two cases, some links may be incorrect – the mistakes are mine.

Corporate Europe Observatory statement on copyright and republication: "All written content on this website is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License."