Preaching objectivity – practicing obfuscation

Deepak Pental

This is in response to a Commentary by Gutierrez *et al*.[1] on my review article[2] that was written as a critique of some very flawed analysis of plant breeding technologies and their impact on food security and the environment by Kesavan and Swaminathan[3–5]. So far, the debate on the use of GM* technologies, at least in India, has been mostly in the newspapers, television and social media. Barring some exceptions, there has been very little investigative journalism on the GM crops. In most of the debates on the television and I have participated in some, the anchors put anti-GM activists and scientists together and let them quarrel – a scene very similar to the way Ideologues and party spokespersons get at one another every evening on the major news channels of India. The other site for the debates has been the social media where invectives are used freely, and prejudices are flaunted without any restraint; any in-depth analysis on this platform is simply not possible. It is a welcome change that a scientific journal of considerable historical relevance is devoting pages to a very critical issue – whether we should use some of the new tools of genetic manipulation to breed better crops for meeting the avowed goal of low-input, high-output agriculture? Hopefully, this will bring some objectivity and a sense of responsibility to the discourse.

The commentary piece by Gutierrez *et al*. has two aspects – one, analysis of some data on GM cotton (already released – *Bt* cotton) and GM mustard (yet to be released), and the other, purely ideological. I will only respond to their data-based analyses of GM mustard as it is devoted entirely to analysing the research work our group has carried out on the development of hybrids in mustard (*Brassica juncea*) at the University of Delhi. Hybrid breeding in crops like maize and rice was a major success story in plant breeding in the 20th century. Successful hybrid production requires two components – good combiners (parents that provide hybrid seed that shows yield advantage in the farmers' field), and a pollination control mechanism. In the words of Gutierrez *et al*. – 'The common approaches and variants used to produce hybrids are: the non-GMO cytoplasmic male sterility systems (CMS), the GM – *barnase–barstar* system, and hand pollination. Conventional CMS pollination control technology is used for the same purpose as GM – *barnase–barstar.* Specifically, the non-GMO hybrid DMH-1 (with non-GMO parents Varuna × EH2) developed using CMS by Pental's team at DUSC, was released in 2008, and is currently designated a National Check. Pental and colleagues claimed that *B. juncea* hybrid (non-GMO DMH-1) "...has given around 30% heterosis over the best national and regional checks in multi-site trials conducted in the north-western states of India". The *barnase–barstar* technology was used to develop the GMO HT (hybrid) DMH-11 using GMO HT events based on the same non-GMO parent lines initially used to develop CMS (non-GMO) DMH-1'.

Gutierrez *et al*. explain the role of pollination control systems in hybrid seed production well but indulge in outright falsehoods in comparing GM versus non-GM hybrids. Their claim that DMH-1 and DMH-11 have the same parentage is false. DMH-1 is a hybrid between the Indian gene pool line Pusa bold (CMS 126-1) and an east European line EH-2; DMH-11 is a hybrid between the Indian gene pool line Varuna (*barnase*) and EH-2 (*barstar*). So sure are they about the parentage of the hybrids that we have developed – they have repeated this claim several times in the Commentary. The second falsehood is that DMH-1 preceded DMH-11. The GM technology-based hybrid[6] was ready in 2002; the CMS 126-1 based hybrid[7] was developed in 2006.

The big inference Gutierrez *et al*. raise after analysis of the data on the trials conducted on the GM hybrid DMH-11 in the growing seasons 2006–07, 2010–11 and 2011–12 (BRL-1), and 2014–15 (BRL-2) is – 'Clearly, had non-GMO DMH-1 been included in all the trials (it was an entry in the 2006–07 trial only), no MSY (mean seed yield) advantage for GMO HT DMH-11 would have been found', and conclude – '…no yield gains accrued compared to the available non-GMO hybrid DMH-1'. The statement and the conclusion are correct only in a limited sense – all the hybrids between the Indian gene pool lines and east European gene pool lines are heterotic for yield to varying levels. However, the statement is misleading in a broader context, and that happens to be the most crucial aspect; CMS 126-1 is stable only in one line – Pusa bold. All our attempts to stabilize CMS 126-1 in other lines belonging to the Indian or the other gene pools of mustard did not succeed. Even in Pusa bold, the sterility tends to break down in some of the plants under low temperature and foggy conditions. It will be extremely cumbersome to locate such semi-fertile plants and rouge them out in large hybrid seed production plots to produce pure hybrid seed. CMS 126-1, therefore, is limited in its application.

In comparison, the *barnase–barstar* system is highly versatile – it works well in all the lines we have tested so far. The response being given here is not new; the GEAC (Genetic Engineering Appraisal Committee) – the apex body which looks after the biosafety studies and makes appropriate recommendations to the Ministry of Environment, Forests and Climate Change (MoEF&CC), Government of India on the release of GM events had been informed of this. During the proceedings of the PIL (Public Interest Litigation – Aruna Rodrigues vs Union of India, IA no. 546 of 2006, in Writ Petition Civil no. 260 of 2005) filed in the Supreme Court of India by the activist author of the Commentary piece, the point – why GM hybrids when a non-GM hybrid was available – had been raised along with some wild charges on the GM mustard trials. Response to all such charges, conjured to mislead the Supreme Court of India and the Public at large, was filed by MoEF&CC in the Supreme Court (IA no. 47 of 2016). Gutierrez *et al*. were in such a tearing

*The term GM stands for genetic manipulation. All conventional breeding through selective sexual hybridization, mutagenesis, polyploidy induction are exercises in genetic manipulation. The correct term should be GE (genetic engineering) – for the manipulations that are based on the recombinant DNA technology – a field that developed in the 1970s. However, I have used the term GM for the new technologies to make it easier for the readers.

Box 1. Studies undertaken for the safety assessment of the GM lines Varuna bn 3.6, EH-2 modbs 2.99 and hybrid DMH-11

Molecular characterization	Gene sequences, constructs and molecular characterization Expression studies of the three inserted genes – *bar*, *barnase* and *barstar*
Food safety studies	Cloning, expression, purification and production of three expressed proteins Equivalence of the Bar, Barnase and Barstar recombinant proteins produced in bacteria with that expressed in transgenic plants Bioinformatics analysis of the three proteins Pepsin digestibility of the three proteins Heat stability of the three proteins Acute oral toxicity of the three proteins in mice Sub-chronic toxicity of leaves and seeds containing the three proteins in rats Compositional analysis
Environmental safety studies	Field trials from 2004 to 2007 BRL-I trials for two growing seasons (2010–11, 2011–12) BRL-II trials for one growing season (2014–15) Weediness potential and aggressiveness parameters Impact on soil microflora during BRL-I and BRL-II trials Crossability and pollen flow studies Pollination behaviour, pollen morphology and physiology
Detection protocols	Protocol for testing at a level of detection (LOD) of 0.01% Development of ELISA kits for Bar, Barnase and Barstar

hurry to respond to my critique of Kesavan and Swaminathan that they forgot to do proper homework on the matter.

It also needs to be emphasized that the primary purpose of the BRL trials is to assure the biosafety of the GM events. Yield assessment is only one of the many parameters that are taken into consideration. A list of the tests that were conducted on the GM lines and their non-GM comparators using the materials generated in the BRL trials is provided in Box 1. All the biosafety tests were carried out in some of the leading public funded laboratories of the country over three years – even though the *barnase–barstar* based hybrid seed production technology was found to be safe in the sister crop rapeseed (*B. napus*) and released for commercial use in Canada in 1996, in the USA in 1999, and Australia in 2003 after very rigorous testing.

The only scientifically legitimate exercise in the Commentary is the regression analysis of the yield data obtained in the four field trials of GM mustard hybrid DMH-11. The analysis clearly shows hybrid DMH-11 outperforming Varuna (one of the parents of hybrid DMH-11, and the National Check variety at the start of the BRL trials). In the words of Gutierrez *et al*. – 'Nevertheless, the yield advantage of HT DMH-11 over Varuna in the BRL-1 and BRL-2 trials were 28% and 26.4% respectively, and as a percentage are essentially the same as found in the 2006–07 trials'. In spite of their analysis showing a clear yield advantage for DMH-11 and consistency in the yield trends across the trials, Gutierrez *et al*. level charges – that the data was inflated at some point, and that the parents were switched during the biosafety analyses. For the data, Gutierrez *et al*. admit – 'We note, however, that the correct 2011–12 MSY data were restored when reported on the Assessment of Food and Environment Safety (AFES) web page'. The GEAC was never given any other data than what was reported in the AFES document. If any submission with wrong calculations on the extent of yield increase was made – the mistake was corrected immediately. All the biosafety studies listed in Box 1 were conducted on EH-2 (*barstar*) and Varuna (*barnase*). EH-2 served as a better male parent (pollen donor) as it is taller and comes to flowering three to four days earlier than Varuna.

Another false allegation by Gutierrez *et al*. that precedes their data analysis is – 'All trials were self-supervised lacking oversight by experienced breeders of the DRMR (Directorate of Rapeseed Mustard Research – an ICAR institute), and the results of the trials were self-analysed by the developers for submission to the regulators'. On the contrary, all the trials were conducted by scientists at trial sites in the ICAR institutes and Agricultural Universities identified by DRMR and were authorized by the regulators. The yield data was taken by the trial-incharge of their respective sites before the crop residues were disposed and Director, DRMR, submitted the reports directly to the regulatory bodies. MoEF&CC submitted all the documents supporting this to the Supreme Court (IA no. 47 of 2016). The authors have seen IA no. 47 (ref. 38 in their Commentary) but have failed to acknowledge the reported facts on the inadequacy of CMS 126-1 and also the evidence on the independence of the trials from the developers.

The anti-GM activists have been spreading misinformation on mustard for the last so many years. While all the published research work is peer-reviewed, the activists can say anything in the press or their submissions to the Court and get away with it. However, activists are always searching for some scientific legitimacy, and a few scientists are ready to provide that. Mercifully, some of the lies circulating earlier have not been repeated in the Commentary due to a fear

of scientific scrutiny. A report by the National Academy of Agricultural Sciences (NAAS)[8] in 2017 titled 'Falsehoods perpetrated by GM technology bashers on GM mustard' has nailed all the misinformation and lies spread by the anti-GM activists. Had Gutierrez *et al*. read the NAAS report carefully, they might not have even felt the need to carry out any of their analysis.

In spite of their findings, based on some regression analysis of the trial data, which showed yield increase in hybrids over pure-line varieties, the two scientist authors of the Commentary, Paul Gutierrez and Peter Kenmore have fallen prey to their ideological bias. All this shows up at the end of the Commentary, where Gutierrez *et al*. quote from an article by late Pushpa Bhargava published in the *Economic and Political Weekly*[9] – 'Genetically modified mustard if approved, will be the first such food crop to be commercially released in India. This will open the floodgates for other such crops making India one of the largest users of genetically modified crops in the world in the next 10 to 12 years. Given that its agriculture is largely in the hands of multinational seed and agrochemical companies, India will end up bartering its freedom for the benefit of a few and the misery of the rest'. This statement is purely ideological and has nothing to do with scientific objectivity. All the obfuscation indulged in by the anti-GM activists and some scientists, and by Gutierrez *et al*. in their Commentary, therefore, is to save India and its poor farmers from the multinationals.

It is essential to set the record straight on our groups' work on oilseed mustard. A review of over thirty years of R&D work will require too much space; therefore, only some key points relevant to the debate on GM technologies in mustard are being pointed out. Our group has published to date sixty papers in peer-reviewed journals on the genetics, genomics, and breeding of oilseed mustard and some allied species. All the research work on mustard has been supported by public funding from the National Dairy Development Board (NDDB) and the Department of Biotechnology (DBT). The biosafety studies conducted on GM hybrid seed technology were funded by the Biotechnology Industry Research Assistance Council (BIRAC). All these organizations belong to the Government of India. Neither I nor any of my long-term collaborators have received any grants or any monetary benefit from a national or a transnational seed or chemical company. The primary breeding objectives targeted by our group have been – heterosis breeding for increasing the yield per se, quality improvement of the oil and seed meal, and disease resistance.

The productivity of oleiferous *Brassicas* in India, and mustard covers more than 90% of the six million hectares under *Brassica* species, is stagnating at around 1.15 tonnes/hectare for the last 10 years[10]. In comparison, the global average productivity has been 2 tonnes/hectare. Europe, China and Canada, mostly growing rapeseed (*B. napus*), have moved from pure-line varieties to hybrids. It is time we use hybrids for enhancing the productivity of oilseed mustard in India and also help the other dryland areas of the world. Contrary to what Gutierrez *et al*. claim, India is not the center of origin or diversity of oilseed mustard. Vavilov suggested central Asia to be the centre of origin as the two parental species of mustard – *B. rapa* and *B. nigra* are panmictic (co-exist) in this area[11]. The Indian gene pool of mustard is very narrow[12]. Some recent work has shown the Chinese germplasm of *B. juncea* to be more diverse with different morphotypes[13,14]. Fortunately, two significantly divergent gene pools – east European and Chinese have been identified; hybrids between the Indian and the east European gene pool lines were shown to be heterotic for yield by our group[15] as far back as 1995. First-generation hybrids like DMH-11 will provide a 20–30% yield increase over the released varieties without any additional inputs. In our recent work, we have developed around 16,000 DH (doubled haploid) lines from crosses between Indian × Indian, Indian × east European, and Indian × Chinese gene pool lines – creating extensive variability for developing the next generation of hybrids that will yield even better.

Through extensive mapping work beginning in 2003, our group has mapped several QTL (quantitative trait loci) influencing yield-related traits[16–19] like seed size, pod density, oil content[20,21], and also quality traits[22–25]. A total of five loci/genes are involved with low glucosinolate content, and two loci/genes are involved with the zero erucic trait. Thus, a total of seven loci will have to be diversified into different genetic backgrounds for developing Canola quality '00' hybrids. All the rapeseed grown in Europe, Canada and China is Canola quality (00). For reasons of culinary preferences, in India, both the regular and quality mustard will be needed.

A robust pollination control system is essential for developing diverse hybrids for different agro-ecologies and hybrids

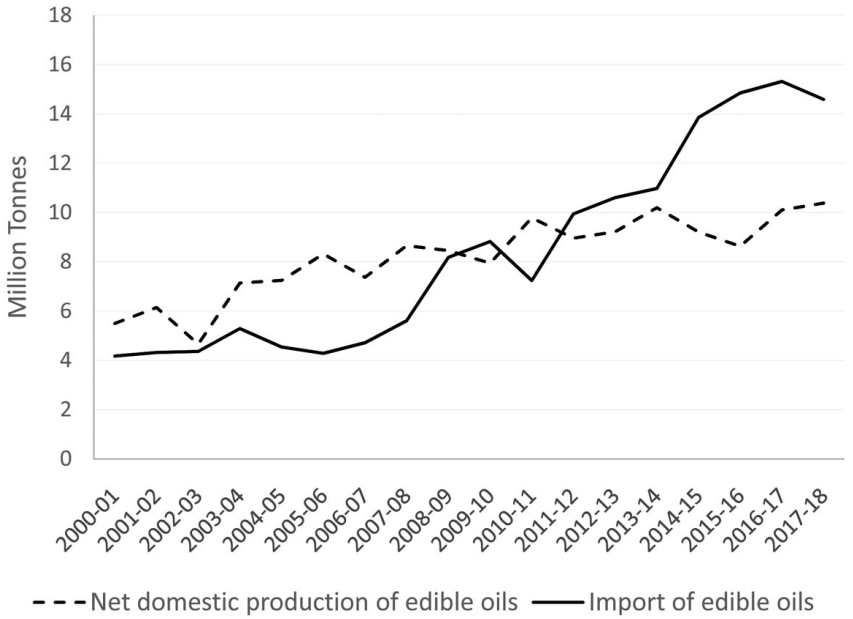

Figure 1. India's domestic production of edible oils and imports (2000–01 to 2017–18). Data taken from *Agricultural Statistics at a Glance 2013 and 2018* available at http://eands.dacnet.nic.in/

with quality traits. The *barnase–barstar* system is the ideal pollination control mechanism for developing hybrids with any set of combiners. Gutierrez *et al*. and many other activists are almost hysteric about the use of herbicides. It has been explained many times over that herbicide Basta (active ingredient – Glufosinate) will be required only in the hybrid seed production plots, and permission will be sought only for limited use. Mustard cultivation does not face much of a problem from weeds, and farmers will not waste their money on an expensive herbicide.

However, hybrid breeding alone will not be enough. Yields of mustard are under serious threat from pests and pathogens[10]. There are three significant diseases – white rust, leaf blight and stem rot, and a significant insect pest – aphids. All mustard varieties and hybrids, presently grown in India, are susceptible to the three diseases and aphids. For white rust, we found resistance in some of the east European and Chinese gene pool lines. We mapped three resistance-conferring loci[26,27], characterized the R genes present in two of the mapped loci[27,28], and transferred two of the three mapped loci to some of the major Indian varieties. The resistant varieties have been provided to eight seed companies and have also been entered in the ICAR multi-site trials. However, no resistance source is available in the primary gene pool of mustard for leaf blight caused *by Alternaria brassicae* and stem rot caused by *Sclerotinia sclerotium*. These diseases will require GM approaches. An alternative is chemical control – that will increase the input costs and has consequences for the environment. A root parasite, *Orobanche aegyptiaca*, has emerged as a significant pest of mustard in large parts of mustard growing areas in the country; so far, it can only be dealt with much-derided glyphosate[29]. Currently, only pesticides can control aphids.

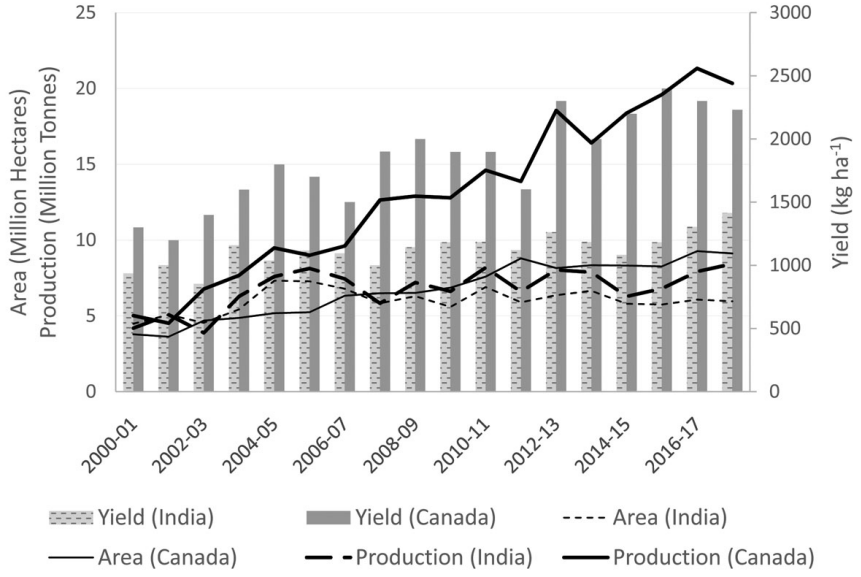

Figure 2. Area, production and yield of rapeseed and mustard oilseeds in India and rapeseed in Canada (2000–01 to 2017–18). Data for mustard in India has been taken from *Agricultural Statistics at a Glance 2018* available at https://eands.dacnet.nic.in/, and for rapeseed in Canada from the Canola Council of Canada available at https://www.canolacouncil.org/markets-stats/statistics/

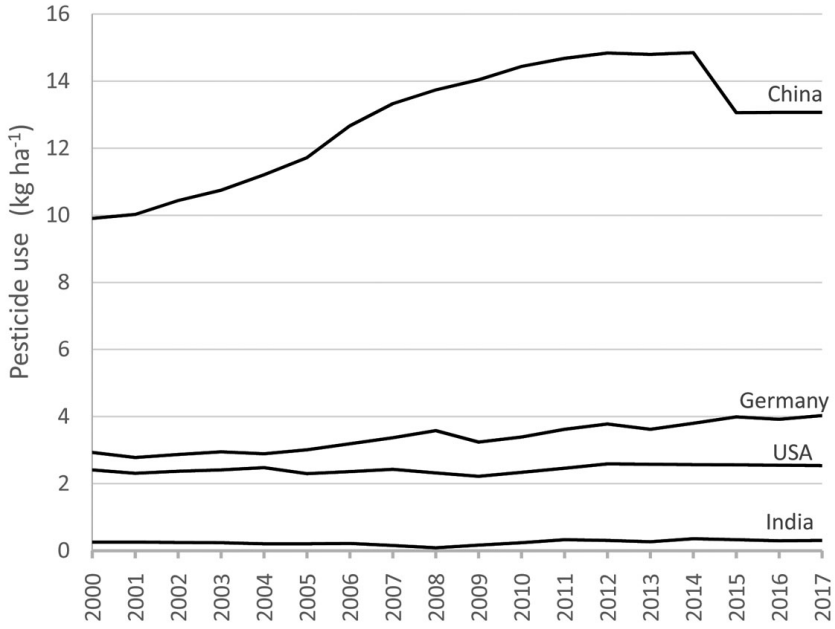

Figure 3. Yearly pesticide consumption in China (mainland), Germany, India and USA (2000–2017). Data taken from FAOSTAT, available at http://www.fao.org/faostat/

In the financial year 2017–18, India produced 10.1 million tonnes (mt) of edible oils, much less than the demand. The country therefore had to import 15.3 mt of edible oils (Figure 1). Both the area under oilseed crops and the yields are stagnating. A comparison of rapeseed cultivation in Canada and mustard in India since 2000 will illustrate the importance of R&D, including the use of GM technologies (Figure 2). More than 93% of the 9.1 mH area under rapeseed in Canada is GM – *barnase–barstar* based hybrids that contain herbicide resistance. In 2017–18, India consumed 3.3 mt of imported soybean oil, 0.3 mt of imported rapeseed oil along with 1.2 mt of cottonseed oil from indigenously grown cotton – all extracted from GM crops. Activists are not opposing the imports – because there are no health risks to show. However, when it comes to agriculture in India – activists only talk of subsidies, higher minimum support price, but never of unleashing the power of science and technology – even when there is overwhelming evidence of safety as in the case of GM mustard.

Major crops grown around the globe are vulnerable to many pests and pathogens[30]. Protection from pests and pathogens will

require either chemicals or gene-based solutions, in some cases – both. A four-country comparison of agrochemical usage shows India to be one of the lowest users of agrochemicals (Figure 3). Thus, a choice will have to be made between chemical or gene-based solutions for increasing the yields. Much of the current global prosperity is due to science and technology. Developing countries require science and technology to defeat poverty, hunger and malnutrition. The lesson from the DDT story is not to reject technology but to be ever so vigilant – and, therefore, evidence-based regulation. If the fear is on food security being hijacked by the transnationals as articulated by Pushpa Bhargava[9] – 'An approval of GM mustard – (making it the first GM food crop to be approved in India) would open the window for other GM food crops to rush in, eventually transferring virtually our entire food production to the largely US-controlled MNCs that have the IPR for GM seeds and with whom we would never be able to compete', we should support open source knowledge generation like our work on mustard and provide the critical technologies to multiple seed companies so that they compete to bring the best value to the smallholding farmers.

The response to new technologies should not be dogmatic opposition but engagement with the latest developments and their creative use. Fear-mongering to scare the public may work, but only at the expense of rationality in decision-making – such tactics should be anathema to the scientific community. Ideologues have their compulsions, and only a few will have the courage like Mark Lynas[31] to change their stance after educating themselves. However, professional scientists should be more objective. They should refrain from casting aspersions on the scientific work of others without repeating the work or going deep into what others are reporting. Obfuscation needs to be shunned, even if it is for a perceived 'higher cause'.

1. Gutierrez, A. P., Kenmore, P. E. and Rodrigues, A., *Curr. Sci*., 2019, **117**, 1422–1429.
2. Pental, D., *Curr. Sci*., 2019, **117**, 932–939; doi:10.18520/cs/v117/i6/932-939.
3. Swaminathan, M. S. and Kesavan, P. C., *Curr. Sci.*, 2018, **114**, 1585–1586.
4. Kesavan, P. C. and Swaminathan, M. S., *Sci. Cult.*, 2018, **84**, 92–97.
5. Kesavan, P. C. and Swaminathan, M. S., *Curr. Sci*., 2018, **115**, 1876–1883; doi:10.18520/cs/v115/i10/1876-1883.
6. Jagannath, A., Arumugam, N., Gupta, V., Pradhan, A., Burma, P. K. and Pental, D., *Curr. Sci*., 2002, **82**, 46–52.
7. Sodhi, Y. S. *et al.*, *Theor. Appl. Genet*., 2006, **114,** 93–99; doi:10.1007/s00122-006-0413-0.
8. 'Falsehoods perpetrated by GM technology bashers on GM mustard' – a report by NAAS scientists. Available at http://naasindia.org – in the scrolling News section as – 'Resolution and Report on GM mustard'.
9. Bhargava, P. M., *Econ. Polit. Wkly*, 2016, **L1**(44 & 45), 40–43.
10. Jat, R. S., Singh, V. V., Sharma, P. and Rai, P. K., *Oilseeds Fats Crops Lipids*, 2019, **26**, 8; http://doi.org/10.1051/ocl/2019005.
11. Vavilov, N. I., *Chron. Bot.*, 1949, **13**, 1–364.
12. Srivastava, A., Gupta, V., Pental, D. and Pradhan, A. K., *Theor. Appl. Genet*., 2001, **102**, 193–199.
13. Yang, J. *et al.*, *Nature Genet.*, 2016, **48**, 1225–1232; doi:10.1038/ng.3657.
14. Yang, J., Zhang, C., Zhao, N., Zhang, L., Hu, Z., Chen, S. and Zhang, M., *Mol. Plant*, 2018, **11**, 512–514; https://doi.org/10.1016/j.molp.2017.11.007.
15. Pradhan, A. K., Sodhi, Y. S., Mukhopadyay, A. and Pental, D., *Euphytica*, 1993, **69**, 219–229.
16. Pradhan, A. K., Gupta, V., Mukhopadhyay, A., Arumugam, N., Sodhi, Y. S. and Pental, D., *Theor. Appl. Genet.*, 2003, **106**, 607–614; doi:10.1007/s00122-002-1083-1.
17. Ramchiary, N. *et al.*, *Theor. Appl. Genet.*, 2007, **115**, 807–817; doi:10.1007/s00122-007-0610-5.
18. Yadava, S. K., Arumugam, N., Mukhopadhyay, A., Sodhi, Y. S., Gupta, V., Pental, D. and Pradhan, A. K., *Theor. Appl. Genet*., 2012, **125**, 1553–1564; doi:10.1007/s00122-012-1934-3.
19. Dhaka, N., Rout, K., Yadava, S. K., Sodhi, Y. S., Gupta, V., Pental, D. and Pradhan, A. K., *Theor. Appl. Genet*., 2017, **130**, 293–307; doi:10.1007/s00122-016-2811-2.
20. Jagannath, A. *et al.*, *Theor. Appl. Genet*., 2011, **122**, 1091–1103; doi:10.1007/s00122-010-1515-2.
21. Rout, K., Yadav, B. G., Yadava, S. K., Mukhopadhyay, A., Gupta, V., Pental, D. and Pradhan, A. K., *Front. Plant Sci.*, 2018, **9**, 1448–1463; doi:10.3389/fpls.2018.01448.
22. Gupta, V., Mukhopadhyay, A., Arumugam, N., Sodhi, Y. S., Pental, D. and Pradhan, A. K., *Theor. Appl. Genet*., 2004, **108**, 743–749; doi:10.1007/s00122-003-1481-z.
23. Ramchiary, N. *et al.*, *Theor. Appl. Genet.*, 2007, **116**, 77–85; doi:10.1007/s00122-007-0648-4.
24. Bisht, N. C. *et al.*, *Theor. Appl. Genet*., 2009, **118**, 413–421; doi:10.1007/s00122-008-0907-z.
25. Rout, K., Sharma, M., Gupta, V., Mukhopadhyay, A., Sodhi, Y. S., Pental, D. and Pradhan, A. K., *Theor. Appl. Genet*., 2015, **128**, 657–666; doi:10.1007/s00122-015-2461-9.
26. Panjabi, P.-M. *et al.*, *Theor. Appl. Genet*., 2010, **121**, 137–145; doi:10.1007/s00122-010-1297-6.
27. Bhayana, L. *et al.*, *Front. Plant Sci*., 2020, **10**, 1690; doi:10.3389/fpls.2019.01690.
28. Arora, H. *et al.*, *Theor. Appl. Genet.*, 2019, **132**, 2223–2236; https://doi.org/10.1007/s00122-019-03350-z.
29. Punia, S. S., *Indian J. Weed Sci*., 2015, **47**, 170–173.
30. Savary, S., Willocquet, L., Pethybridge, S. J., Esker P., McRoberts, N. and Nelson, A., *Nature Ecol. Evolut.*, 2019, **3**, 430–439; https://doi.org/10.1038/s41559-018-0793-y.
31. Lynas, M., *Seeds of Science: Why We Got it So Wrong on GMOs*, Bloomsbury Sigma, 2018.

ACKNOWLEDGEMENTS. Research work on mustard described here has been carried out in long-term collaboration with – Akshay Pradhan, Arundhati Mukhopadhyay, Vibha Gupta, Pradeep Burma, Y. S. Sodhi, and with the participation of many doctoral students and post-doctoral scientists. Funding support was received from NDDB, DBT, CSIR, DST, and BIRAC. Satish Yadava helped with the figures.

Deepak Pental is in the Centre for Genetic Manipulation of Crop Plants, University of Delhi South Campus, Benito Juarez Road, New Delhi 110 021, India
e-mail: dpental@gmail.com

A reply by Gutierrez et al.

Biotechnologist Deepak Pental's strongly worded diatribe[1] against P. C. Kesavan and M. S. Swaminathan[2,3] prompted our initial rebuttal[4], and now he uses similar invective about myself and coauthors P. E. Kenmore and A. Rodrigues as well as P. M. Bhargava whom we quoted.

Pental ignored our analysis of *Bt* cotton in India showing that hybrid *Bt* cotton had little to do with the meager increases in yield that have plateaued since 2006. He dismissed our short history of technological blunders with the