

## **GM MUSTARD TESTING RIGGED FOR UNSCIENTIFIC DECISION-MAKING:**

### **DMH-11 YIELDS 10.4% TO 27.5% LESS THAN OTHER EXTENSIVELY TESTED CULTIVARS!**

This note prepared by the Coalition for a GM-Free India is about the R&D and testing of University of Delhi South Campus (UDSC)'s transgenic mustard hybrid DMH-11, funded by taxpayers' funds from NDDB (National Dairy Development Board) and DBT (Department of Biotechnology, Government of India), the commercialization/'environmental release' application of which is being considered by the Government of India, and its apex regulatory body for GMOs called Genetic Engineering Appraisal Committee (GEAC).

This note seeks to present evidence to show that DMH-11 testing has been rigged to show non-existent benefits from this transgenic hybrid – many more extensively tested varieties and hybrids perform significantly better than DMH-11, as per results from well-coordinated trials.

The transgenic mustard hybrid developed by Centre for Genetic Manipulation of Crop Plants (CGMCP) of Delhi University uses three bacterial genes as part of the bar-barnase-barstar complex where barnase is used for inducing male sterility in Varuna parental line, and barstar in the fertility restorer line of EH2, with the bar gene used for herbicide tolerance, to confer tolerance in the plant to use of pesticide Glufosinate Ammonium.

The main claim made by the developers of DMH-11 is that it increases yield by nearly 25-30%, and by presenting some data on such yield increases, they claim that India's mustard production can be improved and the country's oilseed imports can be brought down. This then presumes the following:

- That yield increases have indeed been confirmed for DMH-11 transgenic mustard hybrid against the current popular non-transgenic varieties or hybrids.
- That there are hardly any other options available to increase production of rapeseed-mustard.

On the above, we seek to present here arguments/evidence that:

- DMH-11 has not been shown to have better yields than currently available non-transgenic varieties and hybrids. DMH-11 has only been shown to have better yields vis-à-vis old checks, deliberately avoiding comparison with approved checks and that there appears to be data suppression to get favourable results.
- DMH-11 testing did not keep pace with ICAR protocols evolved out of collective scientific rigour of hundreds of public sector mustard scientists in India.
- That there are indeed other technological options for increasing yields which need investments and promotion. This is quite apart from pricing and market related policy initiatives that are needed to encourage farmers to go in for more production.

**The background to this is the fact that risk assessment frameworks adopted in regulation should rightly assess both risks but also the claimed benefits to ensure that these are not exaggerated and unreal to achieve, while risks are indeed being taken based on under-analysed risk assessment regimes! Here, we show that the regulators and the crop developers are indeed taking the country for a ride, with regulators' (and government's highest authority's) consent, for unscientific and exaggerated benefits of GM mustard hybrid DMH-11.**

## 1. Yield Performance as claimed by Transgenic mustard hybrid DMH11

DMH-11 has been tested in field trials over 4 years at 18 locations in total. While the data being presented to the regulators for decision-making appears to be focusing only on BRL I (2 years) and BRL II (1 year), spread over 8 locations in total, ICAR-supervised trials took place in 2006-07 also, as Multi-Location trials under All India Coordinated Research Programme, under the coordination of Directorate of Rapeseed Mustard Research (DRMR) of ICAR (NRCRM back then). It is not out of place to mention that trials also took place during 2005-06 Rabi, which were however rejected by the AICRP-RM research project committee since the trial was sown very late (we share the findings in an Annexure for records' sake). We present findings generated from 4 years' trials below.

**Table 1: Seed Yield (Kg/ha) of transgenic mustard hybrid trials conducted under the supervision of NRCRM**

Entry	Delhi	Bharat-pur	Kanpur	Pant-nagar	Nav-gaon	Srigang a-nagar	Kota	Gwalior	Hisar	SK Nagar
Varuna	1395	565	1168	952	1111	1527	2466	592	771	1690
<b>Kranti</b>	1503	940	1380	1232	1097	1606	2433	880	889	2272
Zonal Check	1313	1003	1577	1208	1002	1344	2368	755	740	2295
<b>DMH-1</b>	1884	1098	1110	1666	1434	1501	2488	1289	1302	1975
<b>DMH-11</b>	1748	923	1319	1311	1264	1370	2325	1347	1553	2349

The above trials were conducted under the supervision of ICAR's NRCRM/Bharatpur in 10 locations (Delhi, Bharatpur, Kanpur, Pantnagar, Navgaon, Sriganganagar, Kota, Gwalior, Hisar and SK Nagar) in plot sizes of 25m X 10m. The trial findings are summarized in the table below.

**Table 2: Seed Yield (Kg/ha) performance of transgenic hybrid DMH-11 in AICRP MLRT (2006-07)**

Entry	Seed Yield		% Increase/Decrease of DMH-11 over respective entry
	Range	Mean	
Varuna	565-2466	1224	+26.7%
Kranti	880-2433	1423	+9%
Zonal Check	755-2368	1361	+14%
DMH-1	1098-2488	<b>1575</b>	<b>-1.5%</b>
DMH-11	923-2349	<b>1551</b>	-

The above table shows that DMH-11 had 9.0% higher yield over Kranti and 1.5% lesser yield than DMH-1, on an average. It is worth noting that in the AICRP guidelines used for promotion of entries, any entry not giving at least 10% higher yield over the check is not advanced to further trials.

**Table 3: DMH-11 Seed Yield (Kg/ha) under Biosafety Research Level-I Trial, 1<sup>st</sup> Year (Rabi 2010-11)**

S.No	Entry	ICAR Centre			Mean
		Kumher	Alwar	Sriganganagar	
1.	Varuna (barnase)	1986	1789	2513	2096
2.	EH-2 (barstar)	1730	1842	2455	2009
3.	Varuna	1866	1741	2670	2093
4.	EH-2	1793	1716	2182	1897
5.	Maya/RL-1359(ZC)	2057	1767	2287	2037
6.	DMH-11	2285	2515	3000	2600

It has to be noted that DMH-11 was not compared with Kranti or DMH-1 in these trials in the presentation of findings. It is not clear if they were dropped from the trials or in the presentation of findings. In a later section of this paper, we also show how decisions were taken and implemented.

**Table 4: DMH-11 Seed Yield (Kg/ha) under Biosafety Research Level-I Trial, 2<sup>nd</sup>Year (Rabi 2011-12)**

S.No	Entry	ICAR Center		Mean
		Kumher	Alwar	
1.	Varuna (barnase)	2484	2098	2291
2.	EH-2 (barstar)	1640	1581	1611
3.	Varuna	2375	2169	2272
4.	EH-2	1873	1608	1741
5.	Maya/RL-1359(ZC)	2195	1836	2016
6.	DMH-11	2892	3157	3025 <sup>1</sup>

**Table 5: DMH-11 Seed Yield (Kg/ha) under BRL-II trials (Rabi 2014-15)**

S.No	Entry	ICAR Center			Mean
		Delhi	Bhatinda	Ludhiana	
1.	Varuna (barnase)	1700	1947	1937	1861
2.	EH-2 (barstar)	1110	1562	2001	1558
3.	Varuna	1746	1910	2006	1887
4.	EH-2	953	1442	1739	1378
5.	Maya/RL-1359(ZC)	1571	1791	1965	1776
6	DMH-11	1879	2734	2543	2385

These 3 year trials under the so-called BRL trials of transgenic regulators show a mean yield of 2626 Kgs per hectare for DMH-11 that too based on only 8 locations. When combined with AICRP MLRTs of a previous year in 10 locations, this comes down to **2029 Kgs/ha yield from 4 years of testing of DMH-11 in 18 locations. A pertinent question to ask is why data while being presented to the regulators is keeping out the test results of 2006-07 trials?**

<sup>1</sup>It is worth noting that some experienced mustard breeders are challenging this yield figure and are pointing out that crop developers themselves did the data collection to show such results.

## 2. Other Extensively Tested Cultivars Outperform transgenic mustard hybrid DMH-11

While the presentation of information by the developer appears to show that DMH-11 is indeed yielding at least 27% more than the national check used in the open air trials, let us look at the national checks and zonal checks used.

Varuna, which was used as a National Check and RL 1359 which was used as Zonal Check are old checks. Varuna was released in 1976 and RL 1359 was released in 1987. However, the performance of some recently released varieties and hybrids, that too after extensive testing (both in terms of number of years of testing and number of locations of testing) is given below, as compiled from AICRPRM reports. This data clearly shows that there are many other varieties and hybrids which are better-performing than DMH-11 (2029 Kgs/ha from 18 locations, over 4 years), that too after extensive assessment trials.

The yield potential of these other varieties/hybrids is higher. Why are they not being promoted if yield is the only parameter and the same can be used to bring down India's oilseed import bill?

**Table 6: Mean Seed Yield (Kg/ha) of recently released, extensively evaluated Varieties/Hybrids**

Zone II Entry	Number of Years of Evaluation (Years)	Number of Locations	Mean Seed Yield	% Increase over DMH-11
<b>VARIETIES</b>				
RH 749	5 (2009-10 to 2014-15)	34	<b>2561</b>	<b>+26.2</b>
DRMRIJ 31	4 (2010-11 to 2014-15)	28	<b>2481</b>	<b>+22.3</b>
NRCDR 2	9 (2003-04 to 2013-14)	85	<b>2282</b>	<b>+ 12.5</b>
<b>HYBRIDS</b>				
DMH-1	5 (2009-10 to 2014-15)	52	<b>2586</b>	<b>+27.5</b>
NRCHB 506	8 (2005-06 to 2014-15)	50	<b>2241</b>	<b>+ 10.4</b>
Coral 437	7 (2006-07 to 2010-11)	20	<b>2542</b>	<b>+25.3</b>
<b>DMH-11 (Transgenic)</b>	4 (2006-07, 2010-11, 2011-12, 2014-15)	18	<b>2029</b>	<b>-</b>

A first point to note from the above table is that hybrids are not significantly higher-yielders than varieties. Secondly, compared to the varieties and hybrids listed above and their performance, DMH-11, tested in 18 locations over 4 years, showed a mean yield of only 2029 Kgs/hectare! All varieties and hybrids presented in the above table, (which are presently recommended/ adopted/ available) yield significantly higher than DMH-11.

We repeat again: it is important to note that DMH-11 is being compared with old checks against which it will obviously look higher-yielding (elaborated below)! Further, only 3 years' data is being shown to the regulators.

### 3. DMH-11 testing does not adopt AICRP protocols: Wrong Checks or Comparators selected to make DMH-11 look good

DMH-11 testing used the ICAR establishment for its evaluation, but did not conform to ICAR's well-established scientific norms for evaluation for release of varieties/hybrids. Each year, AICRPRM national workshops with the best scientific expertise related to rapeseed mustard decide upon national and zonal checks. As per these workshops, the checks to be used for assessing hybrids are given below. As can be seen, there is an updation of the comparators at regular frequency because the scientific standards adopted in the central or state varietal release systems are superior, keeping the best interests of farmers in mind. However, DMH-11 testing did not follow these protocols.

**Table 7: Comparators/ Checks recommended by AICRP-RM:**

Year of trial	National checks recommended by AICRP-RM (Year of release)		Zonal checks recommended by AICRP-RM (Year of release)	DMH-11's Checks/Comparators Used by Developer
	Varieties	Hybrids	Variety	
2005-06	Kranti (1982)	-	RL-1359 (1987)	Kranti and Varuna as national checks. DMH-1 also included in trials – trial data not considered however
	Varuna (1975)			
2006-07	Kranti (1982)	-	RL-1359 (1987)	Kranti and Varuna as National Checks; ZC not available. DMH-1 also included
	Varuna (1975)			
2007-08	Kranti (1982)	-	RL-1359 (1987)	
	Varuna (1975)			
2008-09	Kranti (1982)	DMH-1 (2008)	RL-1359 (1987)	
		NRCHB-506 (2008)		
2009-10	Kranti (1982)	DMH-1 (2008)	NRCDR-2 (2006)	
		NRCHB-506 (2008)		
2010-11	Kranti (1982)	DMH-1 (2008)	NRCDR-2 (2006)	Varuna as National Check.
		NRCHB-506 (2008)		RL 1359 as Zonal Check. No hybrids included in data presentation
2011-12	Kranti (1982)	DMH-1 (2008)	NRCDR-2 (2006)	Varuna as National Check.
		NRCHB-506 (2008)		RL1359 as Zonal Check. No hybrids included in data presentation
2012-13	Kranti (1982)	DMH-1 (2008)	NRCDR-2 (2006)	
		NRCHB-506 (2008)		
2013-14	Kranti (1982)	DMH-1 (2008)	RH-749	
		NRCHB-506 (2008)		
2014-15	Kranti (1982)	DMH-1 (2008)	RH-749	Varuna as National Check. RL 1359 as Zonal Check. No hybrids included.
		NRCHB-506 (2008)		

It is worth noting that Kranti was used as a Check in 2006-07 (and in 2005-06, the results of which were not considered); however, no updation of protocols by including latest checks prescribed were done for BRL I and BRL II trials. In the case of DMH-1 testing by the same DU scientists, it appears that protocols were adhered to<sup>2</sup>. How can this be a mere lapse? Does it have anything to do with the fact that DMH-11 did not have at least 10% more yields than Kranti in 2006-07, but was looking very good in front of Varuna, an old check? Varuna was not a Check in the AICRP protocols during those years of BRL I and II testing of DMH-11, but was still used as a comparator. If even non-GM hybrids go through frequent updated protocols so that superior cultivars can be selected after comparison with the latest releases, and also against other hybrids, why was DMH-11 not tested using similar protocols? Is it because DMH-11 would not have looked that good against DMH-1 and RH-749?

#### **4. DMH-11 compared to DMH-1 – data being suppressed?**

In one of the years (Table 1 and 2 of this note) of testing of DMH-11, it was compared with DMH-1, which is a sound way of testing DMH-11. It is understood as per data in Tables 1 and 2 that it does have yields that are higher or significantly higher. It appears that findings that are unfavourable are being suppressed by the crop developers and the regulators are turning a blind eye to the same.

#### **5. DMH-11 has poor performance parameters compared to other best available/adopted varieties and hybrids**

It is important to understand that DMH-11 cannot be assessed only for its yield, that too with incorrect checks and controls, but for other parameters too. In terms of 1000 seed weight, for example, RH-749 is 6.9 gms, NRCDR-2 is 4.9 gms, DMH-1 is 3.6 gms and **DMH-11 is only 3.3 gms**. This small seed size is not preferred by farmers and traders since it fetches lower market price.

#### **6. Simple agronomic changes can lead to 3500 Kg per hectare in mustard cultivation!**

DRMR's testing of the System of Mustard Intensification shows that adoption of intensification strategies could enhance input use efficiencies and create average yields of around 3+ tons per hectare at small farms. This has been shown to increase primary branches, secondary branches and siliqua per plant and significantly improved seed yield. While DRMR's research results show this, adoption of SMI practices in the fields of thousands of farmers in Madhya Pradesh and Bihar show very impressive yield increases.

In Bihar, from the work of civil society groups along with ATMA, it is reported that the maximum yield achieved so far by adopting SRI principles was 1.97 tons per acre, or 4866 Kgs per hectare. A World Bank evaluation in Bihar reported an average increase in oilseed production of 50% using SCI (System of Crop Intensification) methods, with profitability almost doubling, being raised by 93%<sup>3</sup>. SMI is slowly being taken up by farmers of Odhisa, Jharkhand, Punjab and Karnataka also as per the latest reports, depending on promotional

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<sup>2</sup><http://www.slideshare.net/GCProgramme/keynote-icrisat-pental> : "Integrated Breeding: Impacts and Challenges on Crop Productivity in Indian Poor Farmers' Fields", presentation by Dr Deepak Pental, 2011

<sup>3</sup>Behere D, AK Chaudhury, VK Vutukutu, A Gupta, S Machiraju and P Shah (2013): Enhancing Agricultural Livelihoods through Community Institutions in Bihar, India. South Asia Livelihoods Learning Note, Series 3, Note 1. The World Bank, New Delhi and Jeevika, Patna.

investments by either civil society organisations or government departments. In the table below, the figure from DRMR's research is from ongoing research work on campus trials.

**Table 9: Seed Yield (Kg/ha) Increases with System of Mustard Intensification (SMI)**

State	Organisation / Institute	Year	No. of farmers	Average Yield	% increase over DMH-11
Bihar <sup>4</sup>	PRADAN/PRAN	2009-10	7	2964	+46.1%
		2010-11	273	3211	+58.2%
		2011-12	1636	3458	+70.4%
Madhya Pradesh <sup>5</sup>	Department of Agriculture: (crop cutting experiments in 8 fields, out of 12 hectares of farmers' fields)	2012-13	8	4693	+131.3%
Rajasthan <sup>6</sup>	DRMR Research	2013-14	-	3560	+75.5%
<b>Non-SMI (for comparison)</b>					
Hybrid	Developer	Year	No. of farmers	Average Yield	% increase over DMH-11
DMH-1 <sup>7</sup> (Survey in farmers' fields by UDSC)	UDSC/DU	2009-10	63	2124	+4.7%
DMH-11	UDSC/DU	4 years	-	2029	-

<sup>4</sup>[http://sri.cals.cornell.edu/aboutsri/othercrops/otherSCI/In\\_SMImustard\\_Pradan.pdf](http://sri.cals.cornell.edu/aboutsri/othercrops/otherSCI/In_SMImustard_Pradan.pdf)

<sup>5</sup><https://www.dropbox.com/s/146nyi8lbg32us/Rajesh%20Tripathi%20-%20Powerpoint%20-%20SRI%20in%20Mustard.pdf?dl=0> : "Unprecedented Growth Achieved Using SRI Technique (SRI, SMI & SWI), District Umaria (Madhya Pradesh), Year 2012-13 & 2013-14, Department of Farmer Welfare & Agriculture Development, Government of Madhya Pradesh

<sup>6</sup> Directorate of Rapeseed-Mustard Research Annual Report 2013-14:  
[http://www.dmr.res.in/publication/DRMR\\_ar\\_%202013-14.pdf](http://www.dmr.res.in/publication/DRMR_ar_%202013-14.pdf)

<sup>7</sup> Performance of DMH-1 in farmers' fields during 2009-10 – survey results from 63 farmers. Presentation by Dr Deepak Pental: <http://www.slideshare.net/GCProgramme/keynote-icrisat-pental>

## 7. HOW THE REGULATORS AND THE CROP DEVELOPERS COLLUDED TO BREAK DECISIONS ON SCIENTIFIC PROTOCOLS

Decisions in GEAC meetings	Permission Letter	Actual trial
<p>BRL I 1<sup>st</sup> Year Trials permission, 103<sup>rd</sup> meeting of GEAC, 29/9/10:</p> <p>“6.3.2 Transgenic parents Varuna barnase (even bn3.6) and EH2 barstar (event modbs2.99), one non-transgenic parent (EH2), one national check (Varuna) and one check would be planted along with transgenic mustard hybrid DMH-11”</p>	<p>No. BT/BS/17/30/97-PID, dated 15/10/2010, by Member Secretary RCGM in DBT:</p> <p>“a) 1) To generate biosafety data with focus on environmental safety assessment parameters...on productivity of transgenic mustard hybrid DMH-11 corresponding to <b>non-transgenic counterparts and checks.</b></p> <p>d) Trial Protocol: The replicated BRL I trial shall be conducted in triplicate repeats with Randomized Block Design (RBD) at university research farms, to keep the research trials confined. While conducted confined BRL I trials permitted party is <i>directed to follow the trial specification as submitted to RCGM.</i></p>	<p>Convenient checks were used</p>
<p>BRL I 2<sup>nd</sup> Year Trials Decision, 112<sup>th</sup> GEAC meeting on 21/9/2011:</p> <p>“5.14.4 It was also noted that the trials will be done in Randomized Complete Block Design with six replications <b>with transgenic and non-transgenic mustard hybrids</b>”</p>	<p>Letter No. BT/BS/17/30/97-PID, dated 17/10/2011, from Member Secretary, RCGM:</p> <p>“d) Trial Protocol:</p> <p>i) <b>Appropriate National and local checks</b> and spacing are to be included for comparison of the efficacy of the gene in terms of productivity.....</p>	<p>Convenient checks were used</p>
<p>BRL II Trials Decision, 121<sup>st</sup> GEAC meeting on 18/7/2014:</p> <p>“4.4.4 The Committee took note of the field experiment design and proposed isolation measures as given below: Randomised Block Design with five replications <b>with transgenic and non-transgenic mustard hybrids</b>”.</p>	<p>File No. 12013/35/2010-CS-III, dated 28/10/2014 and 7/11/2014, from Member Secretary GEAC:</p> <p>“7.0 Trial Protocol: <b>Appropriate national and local checks</b> and spacing are to be included for comparison of the efficacy of the transgenic mustard hybrid and parental lines in terms of productivity....”</p>	<p>Convenient checks were used</p>



The rigging of DMH-11 evaluation can be summed up as below:

- DMH-11 was intentionally tested against old checks, in an unscientific fashion. There are no results presented to claim that transgenic mustard hybrid is superior in seed yield against best available mustard hybrids and varieties used as national and zonal checks currently, and DMH-11 is shown superior only against old checks/comparators;
- Suppression of unfavourable data and findings where such comparison happened in a limited fashion;
- Non-adoption of ICAR's scientific protocols even as ICAR is used opportunistically to promote DMH-11.
- Non-adherence to GEAC's minutes and permission letter.

**It is shocking that the transgenic regulators are proceeding with the processing of application of developer based on this!**

We also conclude by saying that many high-yielding rapeseed mustard varieties are available, at par with hybrids. Further, most seed sown appears to be farm-saved, as per investigations on the ground. If this is the case, it is important that yield improvements based on non-hybrid technologies and agronomic interventions like System of Mustard Intensification be promoted on a large scale everywhere that they are feasible. It is also seen that even for creation of hybrids, Cytoplasmic Male Sterility (CMS) technology is successfully deployed<sup>8</sup> and it is found stable so there is no reason for the transgenic option to be used. Considering the risks involved with transgenics it is not out of place to remind that the Task Force on Application of Agricultural Biotechnology led by Dr M S Swaminathan – which was accepted by the Government of India in 2004 - had recommended that transgenic options should be explored only when other alternatives are unavailable or not feasible. This is not the case with rapeseed mustard.

We anticipate that crop developer and his team will respond by saying that they have followed protocols prescribed by the regulators. This answer is untrue, untenable and insufficient, given that any scientist vouching to have high scientific standards and rigour as well as the best interests of farmers in mind, will not be resorting to such poor unscientific experimentation. Such experimentation at the expense of farmers' lives and livelihoods is not acceptable, and foolproof assessments are an absolute must, especially given that India lacks a liability regime on transgenic crop developers and the regulators for failures as well as risks being taken without adequate risk assessment.

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<sup>8</sup>[http://gcirc.org/fileadmin/documents/Bulletins/B23/B23\\_06.pdf](http://gcirc.org/fileadmin/documents/Bulletins/B23/B23_06.pdf) : This paper, co-authored by Deepak Pental says that CMS technology is the most flexible and amenable system for hybrid seed production and presents the advantages of the tool.

**Annexure Table: Seed Yield (Kg/ha) from transgenic mustard hybrid DMH-11 trials in 8 locations under the supervision of NRCRM, Bharatpur in 2005-06, data of which was not considered because of late sowing**

<b>Strain</b>	<b>Delhi</b>	<b>Bharatpur</b>	<b>Kanpur</b>	<b>Pantnagar</b>	<b>Navgaon</b>	<b>SK Nagar</b>	<b>Kota</b>	<b>Gwalior</b>	<b>Hisar</b>	<b>Mean</b>
Varuna	1886	1441	1083	806	258	2049	1960	737	1886	1345
Kranti	1774	1851	1055	978	304	2088	1528	813	1774	1351
Zonal Check	1615	1879	1261	954	409	2598	1597	1033	1615	1440
DMH-1	2391	1710	1236	1182	516	2367	1636	1080	2391	1612
DMH-11	2415	1817	1294	1194	437	2673	1675	1104	2415	1669