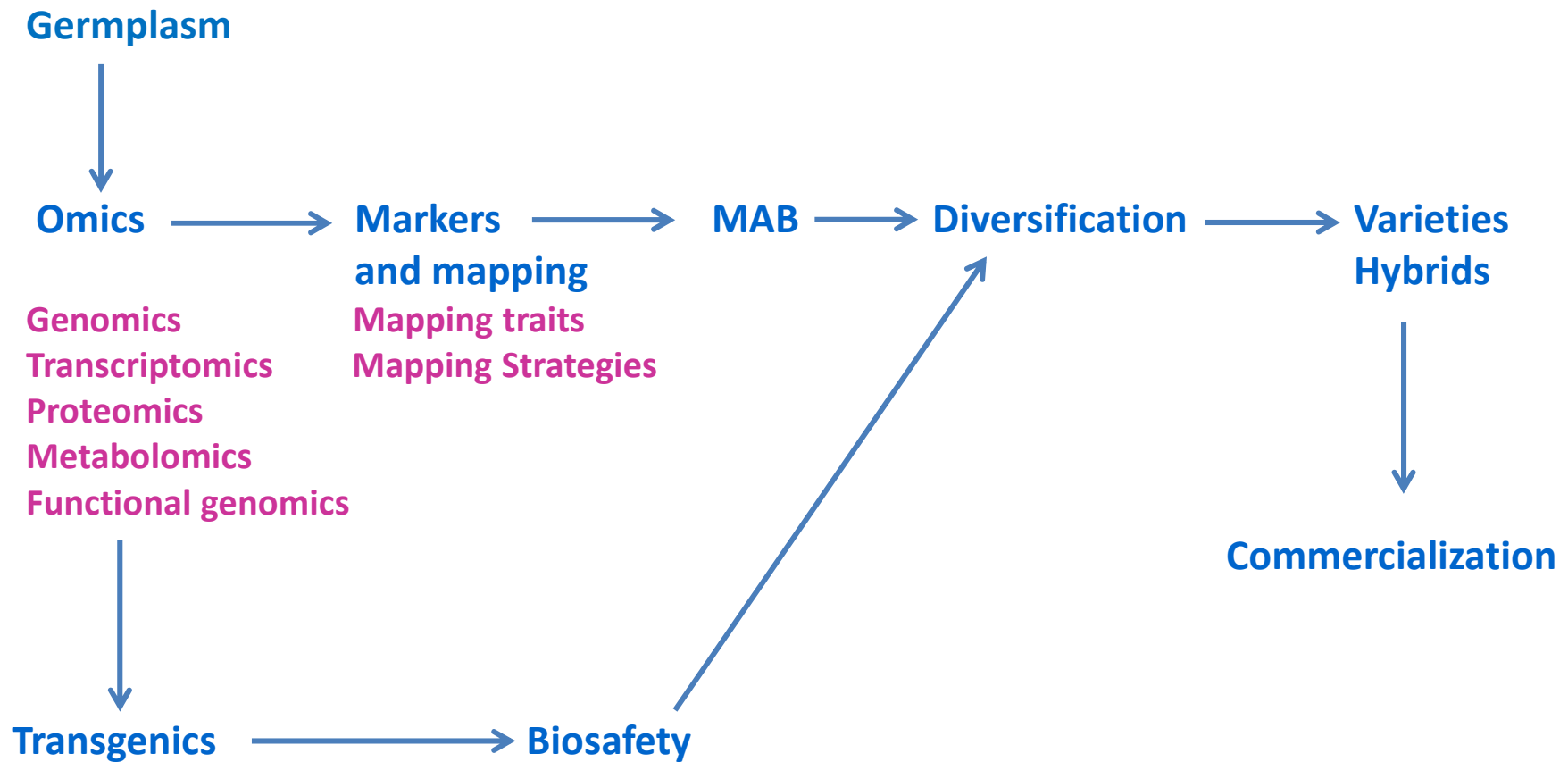


Opportunities and Challenges



Transgenic Mustard Hybrid DMH-11

- Hybrid between Varuna (Indian) x EH2 (east European)
- Male sterility, fertility restoration based on genetic engineering technologies
- Brown seeded, ~ 41% oil
- DMH-11 tested in plot-level trials in 2003-2006 under containment following biosafety guidelines of GoI
- DMH-11 has completed two year BRL-I trials under ICAR. All biosafety studies have been completed and submitted to GEAC for BRL-II trials in 2014-15
- Heterosis over national check Varuna reported between 24-32%

Environmental Safety Studies

Completed

- Expression studies for *bar*, *barnase* and *barstar* genes in various plant tissues
- Studies on weediness potential/ aggressiveness
Comparative assessment of seed germination and seedling vigour
- Parameters affecting pollen flow
- Impact on soil microflora
- Level of detection at 0.01% for presence of transgenic hybrid DMH-11

Toxicity Studies

Completed

- **Toxicity Assessment**
 - **Acute Toxicity studies using pure proteins**
 - **Sub-chronic studies using leaves and seeds**

(reports submitted to RCGM and GEAC)

- **Allergenicity**
 - **Bioinformatics**
 - **Pepsin digestibility**
 - **Heat stability**

(reports submitted to RCGM and GEAC)

- **Compositional analysis of leaves, seeds and seed meal**

(reports submitted to RCGM and GEAC)

Regulatory approval status of GM canola with *barnase/barstar* system

Event	Country	Environment	Food and Feed	Food	Feed
ACS-BNØØ4-7 x ACS-BNØØ1-4 (MS1, RF1 =>PGS1)	Australia	2003	2002		
	Canada	1995		1995	1995
	China		2004		
	European Union		2005		
	Japan	1996		1996	1996
	Korea			2005	2008
	South Africa		2001		
	United States	2002	1996		
ACS-BNØØ4-7 x ACS-BNØØ2-5 (MS1, RF2 =>PGS2)	Australia	2003	2002		
	Canada	1995		1995	1995
	China		2004		
	European Union		2005		
	Japan	1997		1997	1997
	Korea			2005	2008
	South Africa		2001		
	United States	2002	1996		
ACS-BNØØ5-8 x ACS-BNØØ3-6 (MS8xRF3)	Australia	2003	2002		
	Canada	1996		1997	1996
	China		2004		
	European Union		2005		
	Japan	1998		1997	1998
	Korea			2005	2005
	Mexico		2004		
	United States	1999	1996		

Estimated acreage and percentage of HT and conventional Canola in Canada

Year	Total Acres Harvested (000)	Total Production (000 tonnes)	Roundup Ready (transgenic; herbicide tolerant)	Liberty (transgenic; herbicide tolerant)	Clearfield (not transgenic; herbicide tolerant)	Conventional
			<i>% of acres</i>			
1995	13,200	6,436	0	0	0	100
1997	12,000	6,266	4	8	14	74
1999	13,700	8,798	35	18	18	29
2001	9,601	5,062	45	16	20	19
2003	11,600	6,669	48	22	19	12
2005	12,980	9,660	45	34	14	7
2007	15,511	9,529	47	41	11	2
2009	15,755	12,417	51	40	7	1
2010	16,097	11,866	47	46	6	1

*Numbers may be slightly off due to rounding

Source: Provincial databases, seed company information, surveys and Statistics Canada

Seed exports (Historic) - Canada

Historic Canadian Canola Seed Exports - updated February 7, 2014 (000 Tonnes) Calendar Year (January - December), Crop Year (August 1 to July 31)												
	2002 Cal. Yr.	2003 Cal. Yr.	2004 Cal. Yr.	2005 Cal. Yr.	2006 Cal. Yr.	2007 Cal. Yr.	2008 Cal. Yr.	2009 Cal. Yr.	2010 Cal. Yr.	2011 Cal. Yr.	2012 Cal. Yr.	2013 Cal. Yr.
Bangladesh	0	13	22	23	87	106	87	105	187	152	147	10
China	66	319	269	310	391	601	1476	3140	1520	1334	2987	2670
EU-27	8	2	1	0	1	2	2	96	129	337	101	44
Japan	1508	1681	1620	1885	1923	1915	2197	1961	2107	2328	2349	2312
Mexico	489	693	1081	1009	1045	1114	1282	1073	1485	1443	1543	1391
Pakistan	0	398	4	97	443	420	94	387	703	813	228	0
U.A.E.	0	0	0	34	330	217	505	306	773	803	534	233
U.S.A.	135	112	442	440	727	630	961	560	551	668	414	401
Others	1	22	1	2	176	10	56	2	13	12	30	30
TOTAL	2206.0	3241.5	3440.1	3797.4	5122.1	5014.1	6661.0	7630.2	7469.7	7890.0	8333.0	7090.4

*Numbers may be off due to rounding.

Source: Canadian International Merchandise Trade Database - Statistics Canada

Fatty Acid Composition of '0' Erucic and '0' Erucic High Oleic Mustard Lines

Oil types	14:0	16:0	18:0	18:1	18:2	18:3	22:1
Mustard Oil	0.0	2.63	1.15	12.09	16.17	12.09	46.87
Olive Oil	0.0	9.53	3.2	77.91	6.33	0.57	0.0
'00' Canola	0.0	4.97	0.74	60.29	21.39	10.49	0.38
'0' Erucic mustard*	0.0	4.1	1.1	53.4	23.9	15.5	0.0
'0' Erucic high oleic mustard*	0.0	2.2	1.2	74.8	9.5	9.3	0.0

* These lines have been developed in this project

16:0 Palmitic acid, 18:0 Stearic acid, 18:1 Oleic acid, 18:2 Linoleic acid, 18:3 Linolenic acid, 22:1 erucic acid

Challenges in Biosafety data generation and analysis

- **Case by case approach**
- **Government should encourage setting up CROs in the area of toxicology**
- **Train young people in biosafety data generation/ data analysis/dossier preparation**
- **Deploy transgenics with minimal tests where safe use has been shown elsewhere**
- **Tough liability laws if false data is submitted**