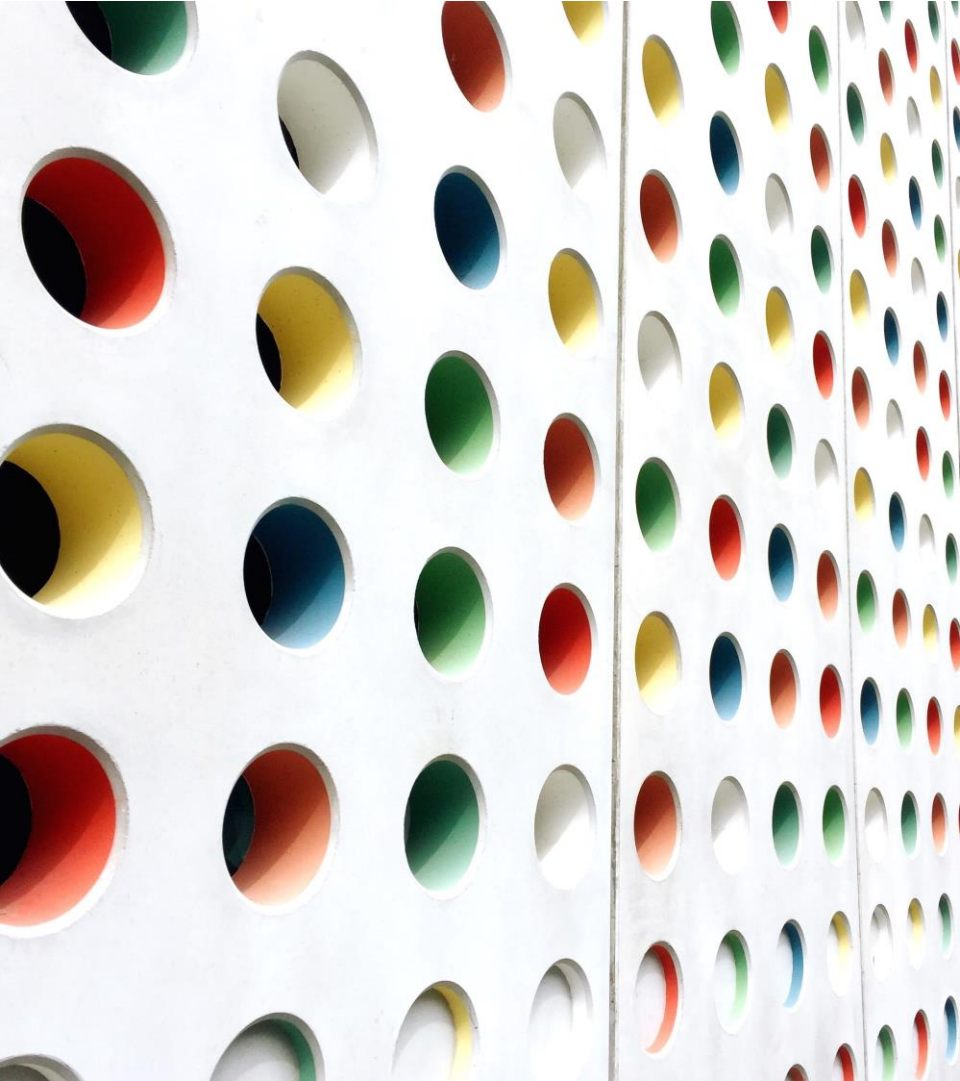




#AtmaNirbharInEdibleOil

New Technologies for Self-Reliance in Edible Oil in India

@5F Conference 2023

DR.C.D. MAYEE

PRESIDENT OF SOUTH ASIA
BIOTECHNOLOGY CENTRE (SABC),
JODHPUR WWW.SABC.ASIA

Indian Agriculture @75

What has changed ? (1)

Parameter *	1950-51	2020-21
Population (Crores)	50	135
Life Expectancy (Years)	42	68
Net Sown Area (m/ha)	131	140
FG Production (mt)*	25	315
Oilseeds production (mt)	05	38
Fruits and vegetable (mt)*	51	333
Cotton (m bales)*	05	37
Sugarcane (mt)*	57	431

* **ATMANIRBHAR BHARAT**

Indian Agriculture @75

What has changed ? (2)

Parameter	1950-51	2020-21
Milk (mt)*	25	210
Egg (Billion No)*	02	1222
Honey (Tons)*	700	1,33,000
Fish (mt)	>1	14.2
Spices (mt)*	0.02	11.0
GVA / Output (Billion USD)	<10	532
Organic Farming (%)	100	02

*** ATMANIRBHAR BHARAT**

Indian Agriculture Today

- Fifth largest economy after US, China, Japan and Germany (3,894 Billion USD) but second largest in Agri output (532 Billion USD).
- The Operational holding is just 1.08 ha down from 2.28 ha in 1970's
- Small-scale mixed farming is Indian strength. Small scale farm, farming and farmers is a 'NATIONAL PRIDE' (PM,2021)
- Work force in farms reduced from 60% to 42% in last 20 years

Indian Agriculture @ 75

WHAT WE MISSED IS

***ATMANIRBHARTA-NEEDED: EDIBLE OIL**

#Atma Nirbhar In Edible Oil



**EDIBLE OIL SCENARIO:
WHERE WE ARE, WHAT WE
SHOULD DO**



**GLOBAL EXPERIENCES:
GENETICS, TRAIT &
TECHNOLOGY IN EDIBLE
OIL SECTOR**



**A CASE STUDY OF INDIAN
MUSTARD (*BRASSICA
JUNCEA*)**

Edible Oil Economy of India

- **India's edible oil market is around \$35 billion (Rs 2.75 lakh crores)**
- **Per capital consumption of edible oil at around 18-19 kg per annum, the total requirement is around 21-22 million metric tons**
- **Domestic production of edible oil estimated at 8+ MT, nearly one third of the total requirement**
- **Edible oil deficit of 14-15 MT per annum**
- **Demand-Supply gap is met through imports costing the nation around Rs. 1.5 lakh Crores per annum (US\$20 billion per annum)**

Edible Oil Basket of India

Conventional

Soybean

Groundnut

Rapeseed Mustard

Castor

Sesame

Sunflower

Linseed

Safflower

Niger

Coconut (Plantation)

Non-Conventional

Rice Bran

Cotton Seed

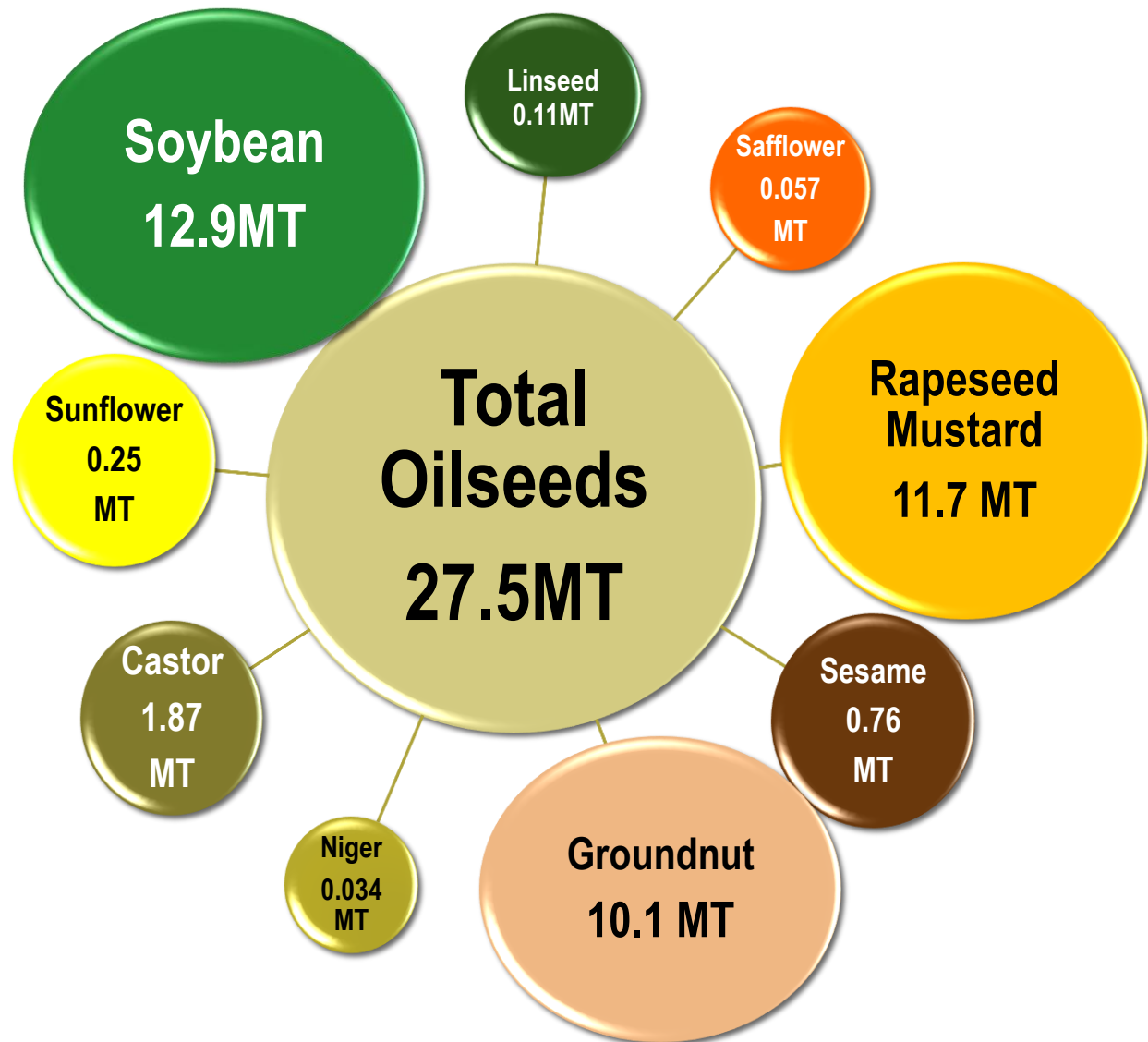
Olive
(Plantation)

Conventional (Relatively new)

Oil Palm
(Plantation)

Tree & Forest
Origin
(For Tribal &
Special)

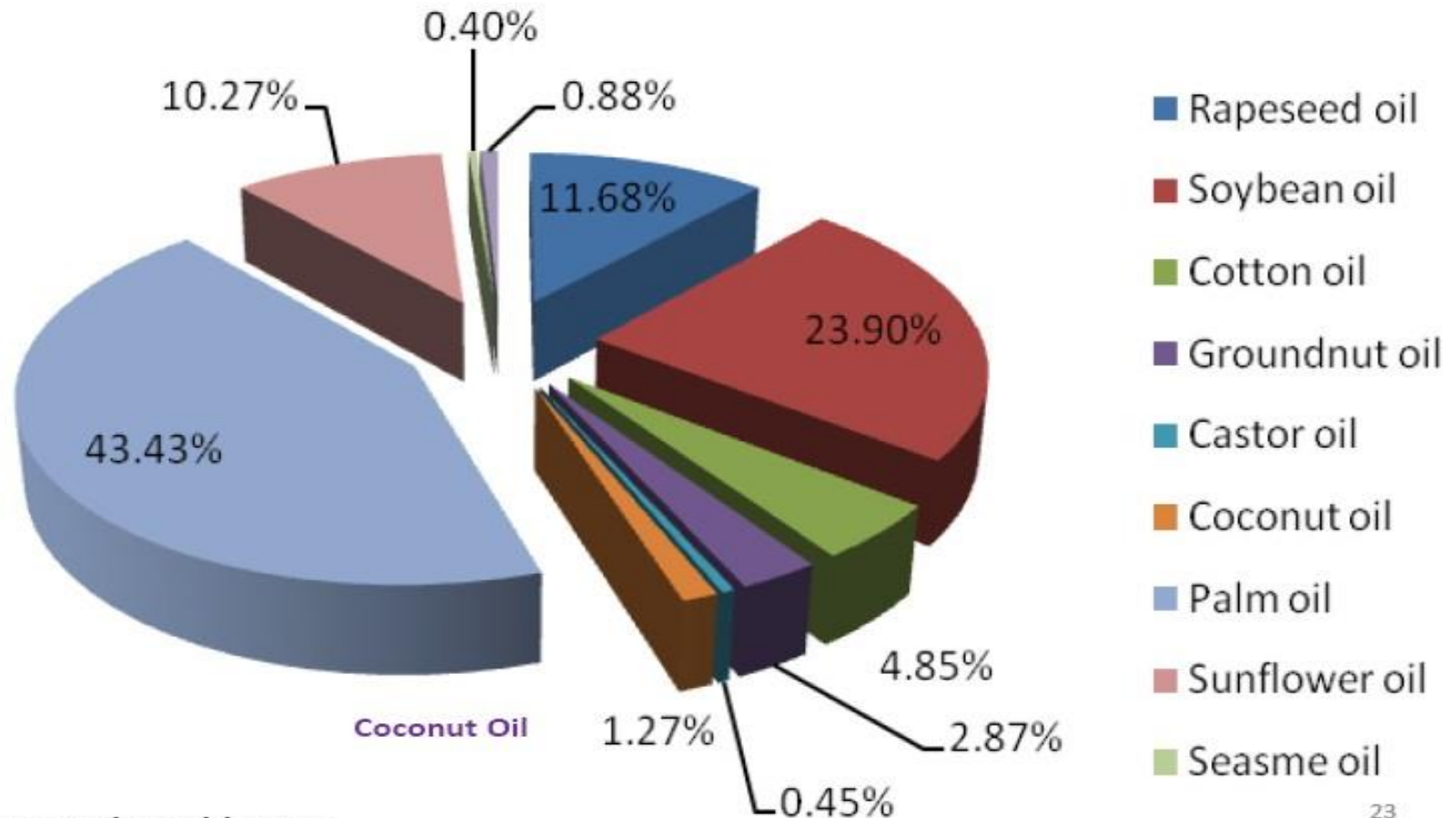
Production of Total Oilseeds, 2021-22 37.6 million tons



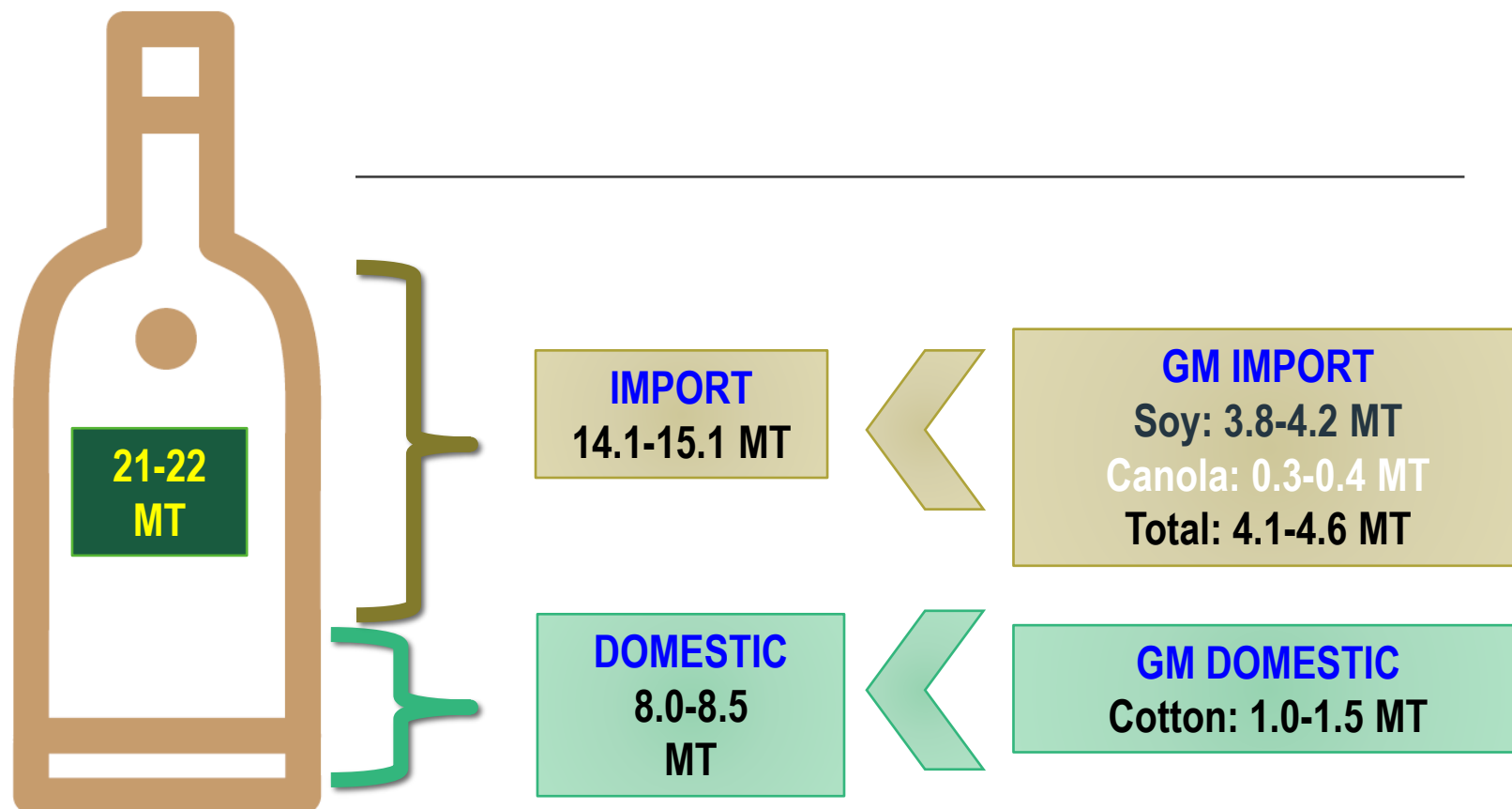
Source: Analysed by SABC, 2017

Consumption of different vegetable oils in India

Consumption of different vegetable oils in India



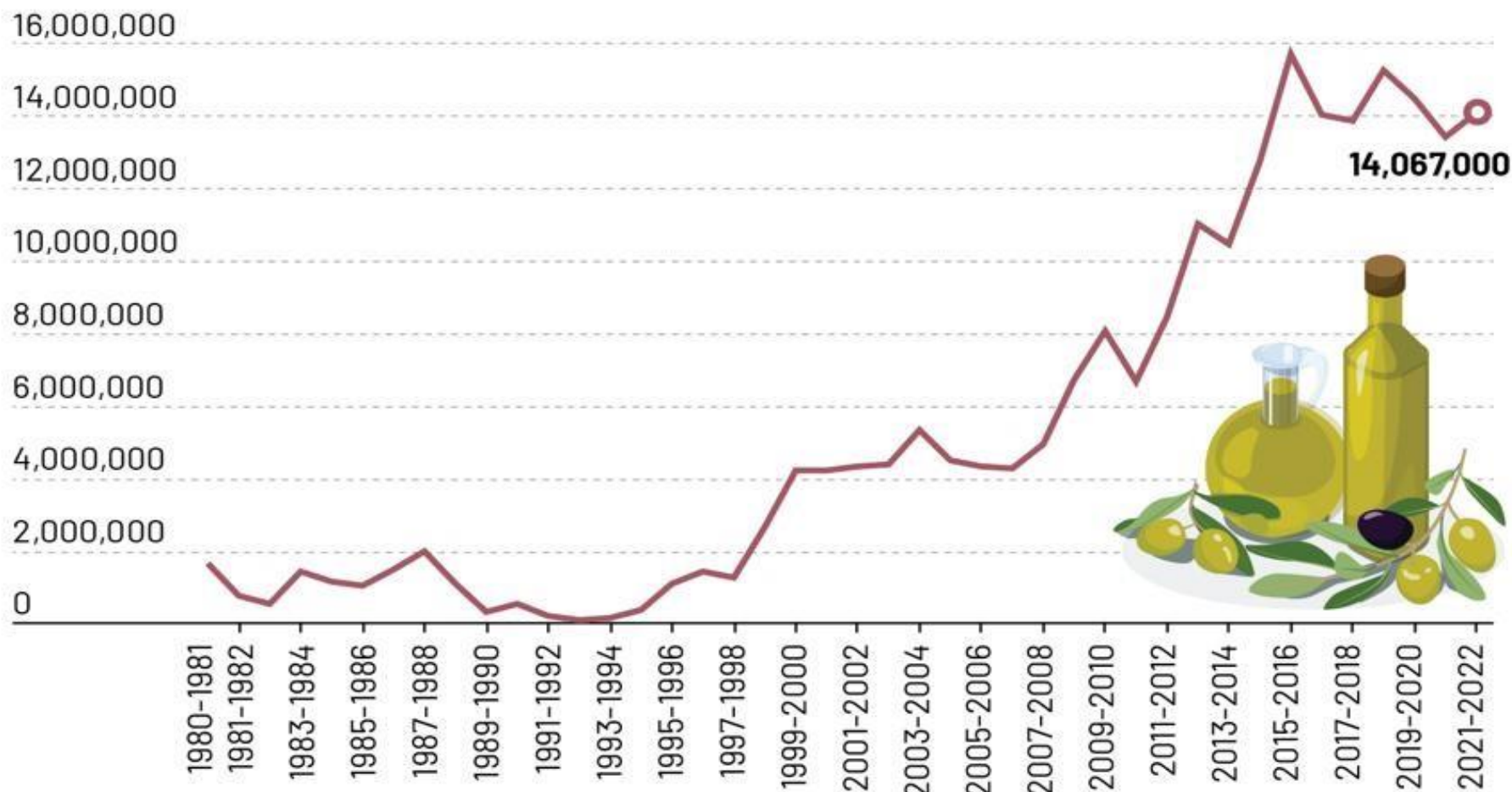
Edible Oil Scenario in India, 2020-21



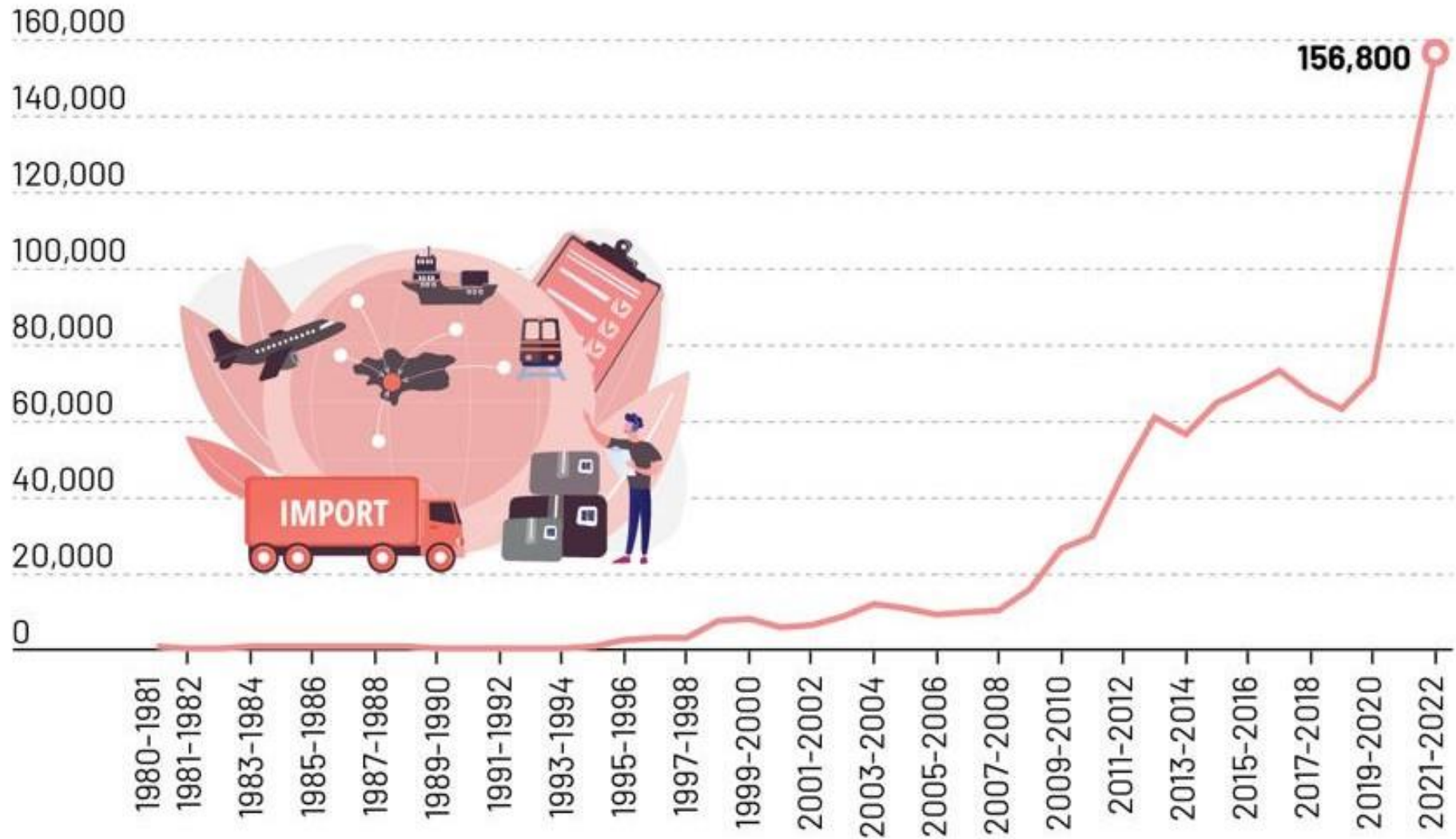
5-6 MT OF EDIBLE OIL DERIVED FROM GM SOY, CANOLA & COTTON CONSUMED ANNUALLY OR ALMOST 20% OF TOTAL CONSUMPTION OF EDIBLE OIL IN INDIA

Edible oil import trend in India between 1980 to 2022

Edible Oil Import (Metric tons)



Cost of Imported Edible Oil (INR crore)

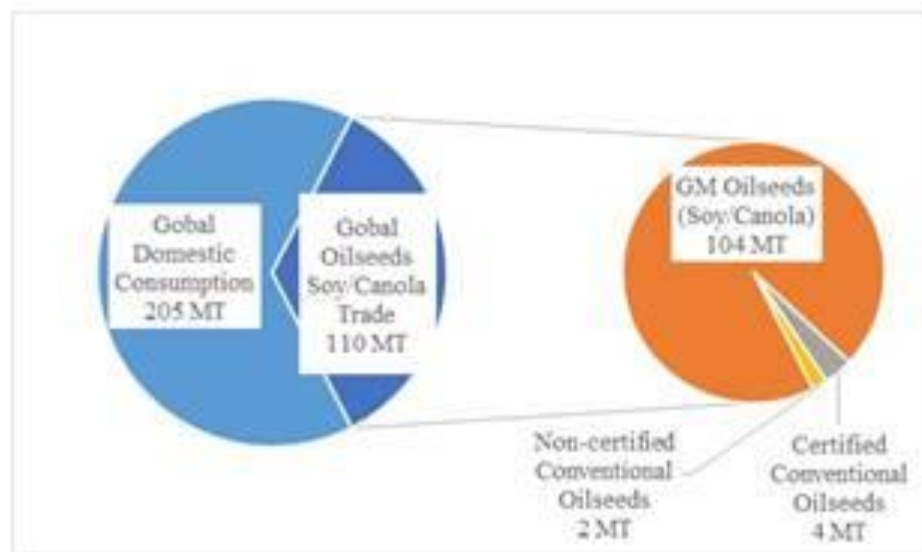


Global and Domestic Producers & Exporters and Importers of Major Edible Oils (Quantity in Million Tonnes)

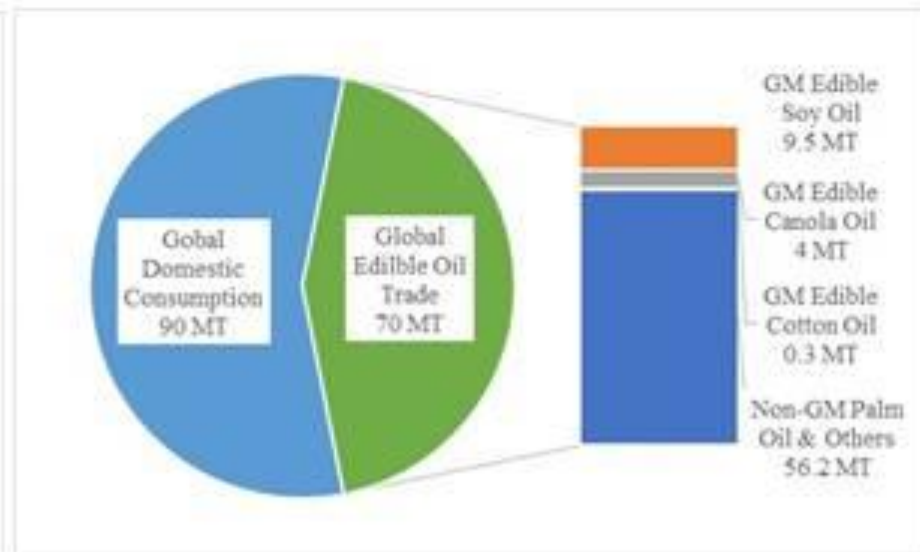
Edible Oil	Global Production (2019-20)	India's Production (2019-20)	Major Exporters / Importers (2018-19)
Ground nut oil	5.93	1.13	Exporters: Argentina, Brazil, Senegal Importers: China, Italy, USA
Mustard Oil	27.43	2.58	Exporters: Canada, Germany, Russia Importers: USA, China, Netherland
Sunflower Oil	19.86	0.07	Exporters: Ukraine, Russia, Netherland Importers: India, China, Iran
Soybean Oil	57.20	1.75	Exporters: Argentina, Brazil, USA Importers: India, Bangladesh, Algeria
Palm Oil	76.01	0.20	Exporters: Indonesia, Malaysia, Netherland Importers: India, China, Pakistan

Source: Global Production: USDA, India's Production: DVVOF, Exporters & Importers: Comtrade

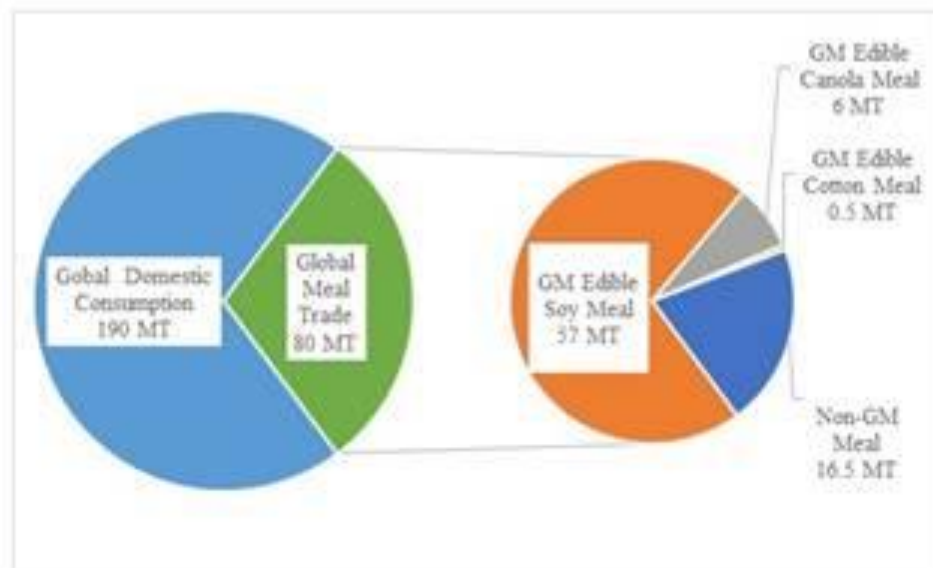
GM Crops & Global Oilseed Grain Trade



GM Crops & Global Edible Oil Trade



GM Crops & Global Animal Feed/Meal Trade



Edible Oil Economy - Future

- **Per capita consumption growing at 5% per annum**
- **Growth in demand may be closer to 4% in future**
- **Indian consumption may touch 30 MT by 2030**
- **At current rate domestic supply of edible oil production would be around 9-10 MT by 2030**
- **Demand-supply gap increasing rapidly to 21MT**
- **For self sufficiency by 2030, country will need over 120 MT of oilseed production from current 38 MT.**
- **Thus, we need to tripple the production in next few years to achieve self sufficiency**
- **Edible oil deficit is a ticking time bomb**

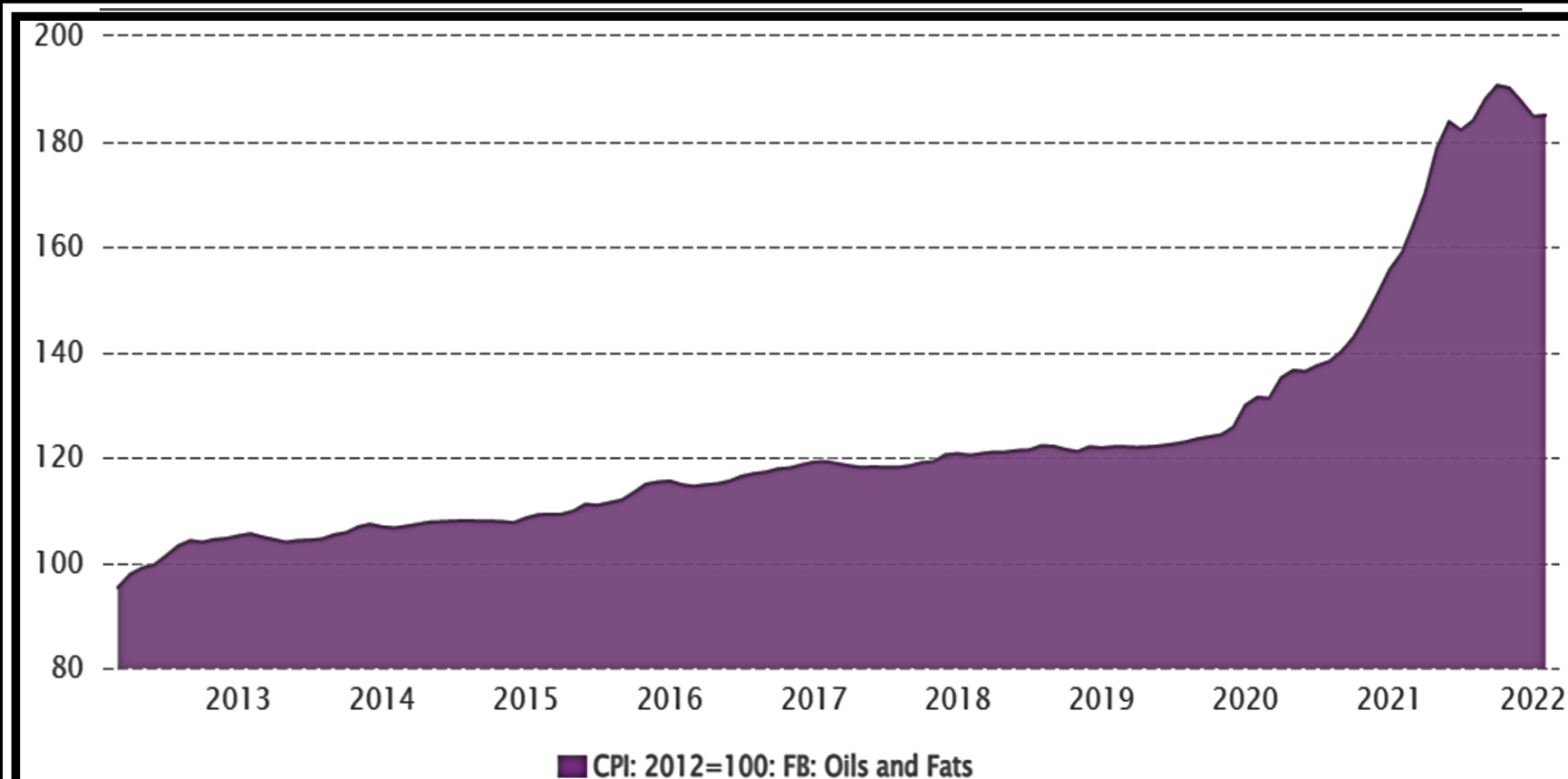
Projection of Edible Oil Requirement

Best Case Scenario: 2020, 2030, 2040,& 2050

	2020	2030	2040	2050
Projected population (billion)	1.32	1.43	1.55	1.68
<i>Per capita consumption based on 40,45,50 and 55 per cent above the prescribed consumption levels</i>				
Per capita consumption (kg/annum)	15.33	15.88	16.43	16.97
<i>Projected requirement (million tonnes)</i>				
Vegetable oil requirement for direct consumption	20.24	22.71	25.47	28.51
Vegetable oil requirement for non food industrial use	3.57	6.34	8.88	10.65
Total vegetable oil requirement	23.81	29.05	34.35	39.16
<i>Projected production of vegetable oilseeds (million tonnes)</i>				



Double Digit Inflation: India Consumer Price Index (CPI) registering highest inflation in edible oils in Food and Beverages category, 2012 to 2022

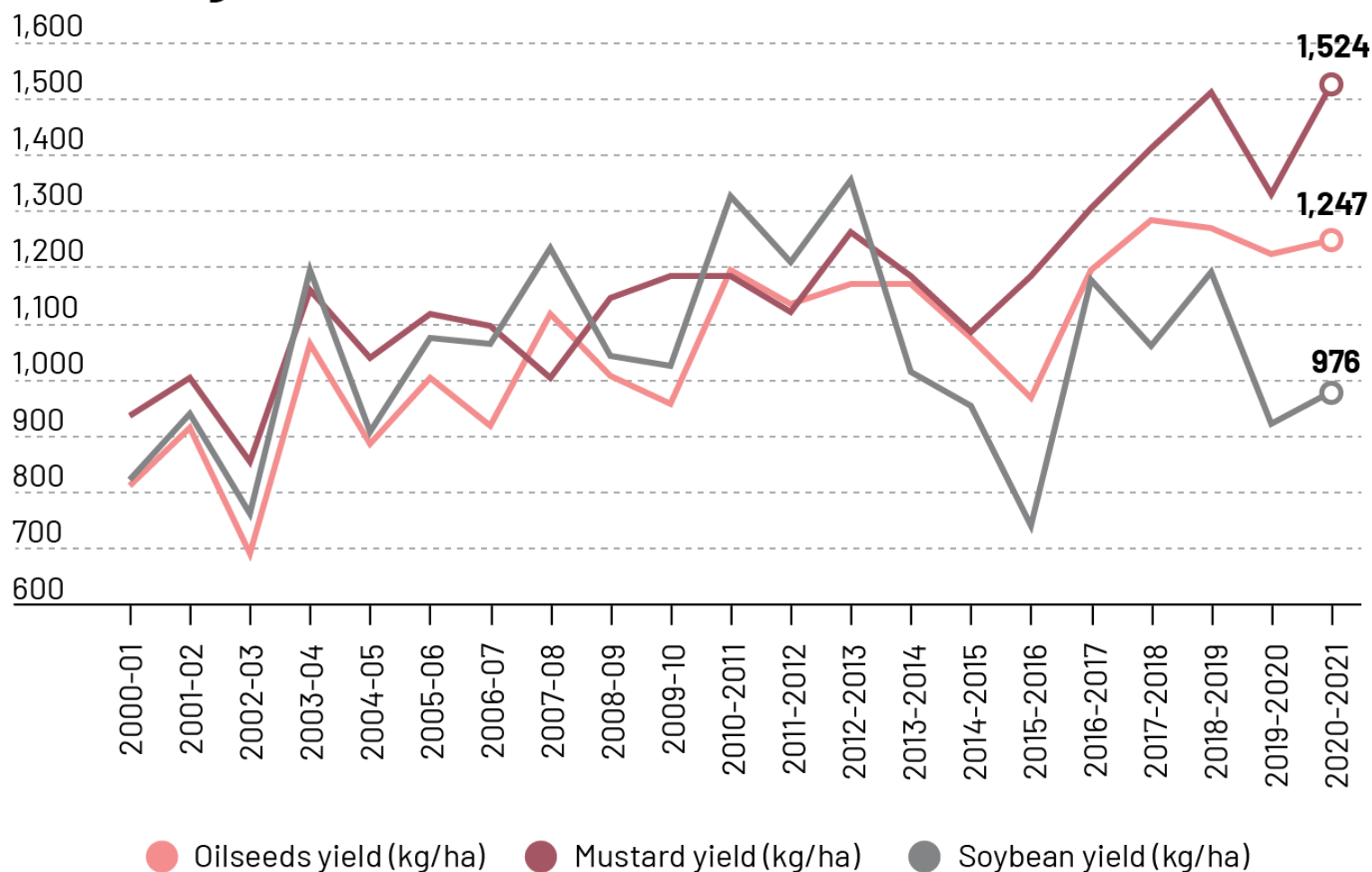


SOURCE: WWW.CEICDATA.COM | Ministry of Statistics and Programme Implementation

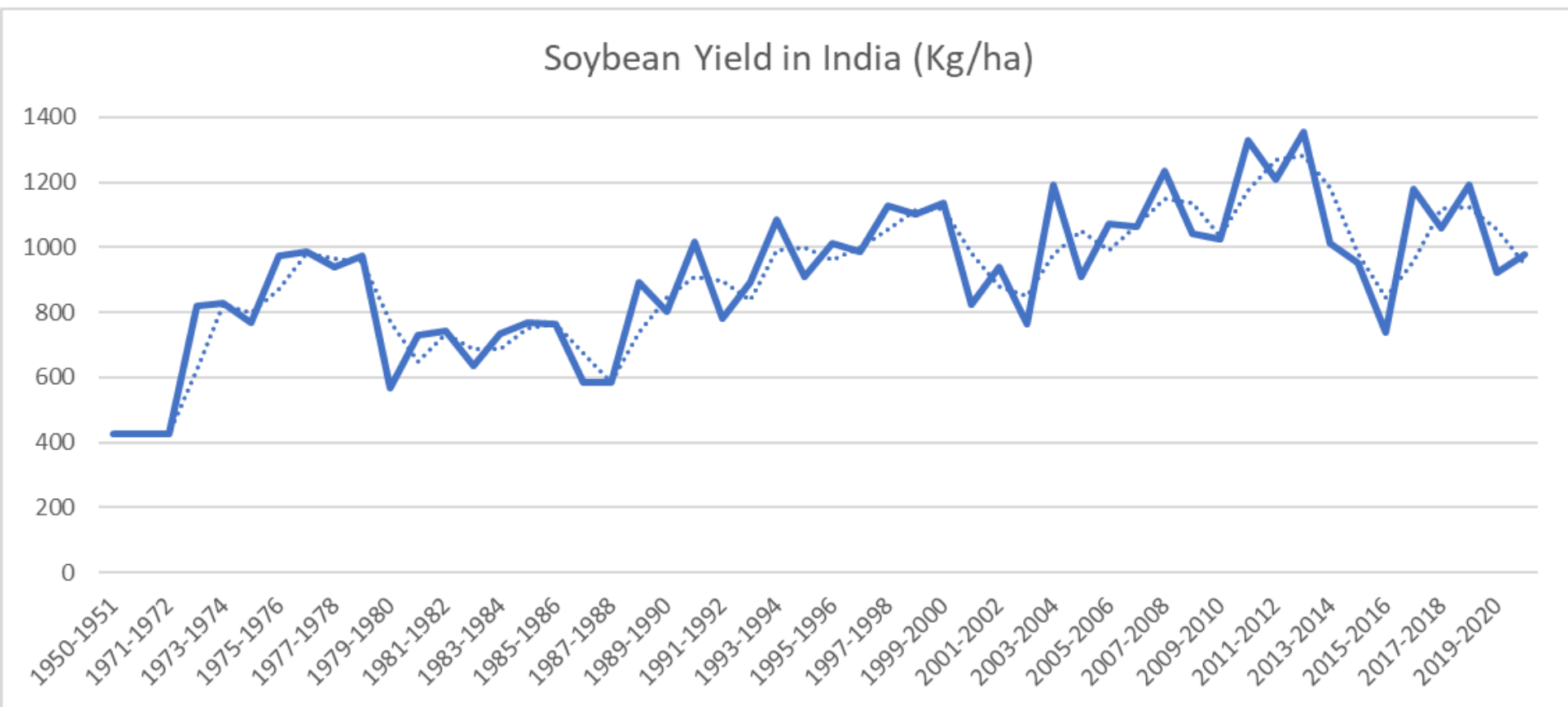
PRODUCTION WOES OF OILSEED CULTIVATION

- **Nearly 64% grown in rain-dependent areas with uncertain rainfall**
- **Grown on marginal to poor soils and poor management because of low profitability in comparison to other rain fed crops**
- **Major breakthrough in yield barrier not achieved due to limited gene pool & heterosis breeding. Lack of sources of resistance to biotic and abiotic stresses and limited efficient weed management practices**
- **Except Groundnut, Soybean, Rapeseed Mustard with productivity per ha of 1100 kg+, the per ha yield of Sunflower (706 kg), Safflower (590 kg), Linseed (478 kg), Niger (300 kg) and Sesame (431 kg) have not attracted commercial status**
- **Lack of cohesive policy on MSP & procurement**

Yield trend in oilseeds, mustard and soybean in India between 2000 to 2021

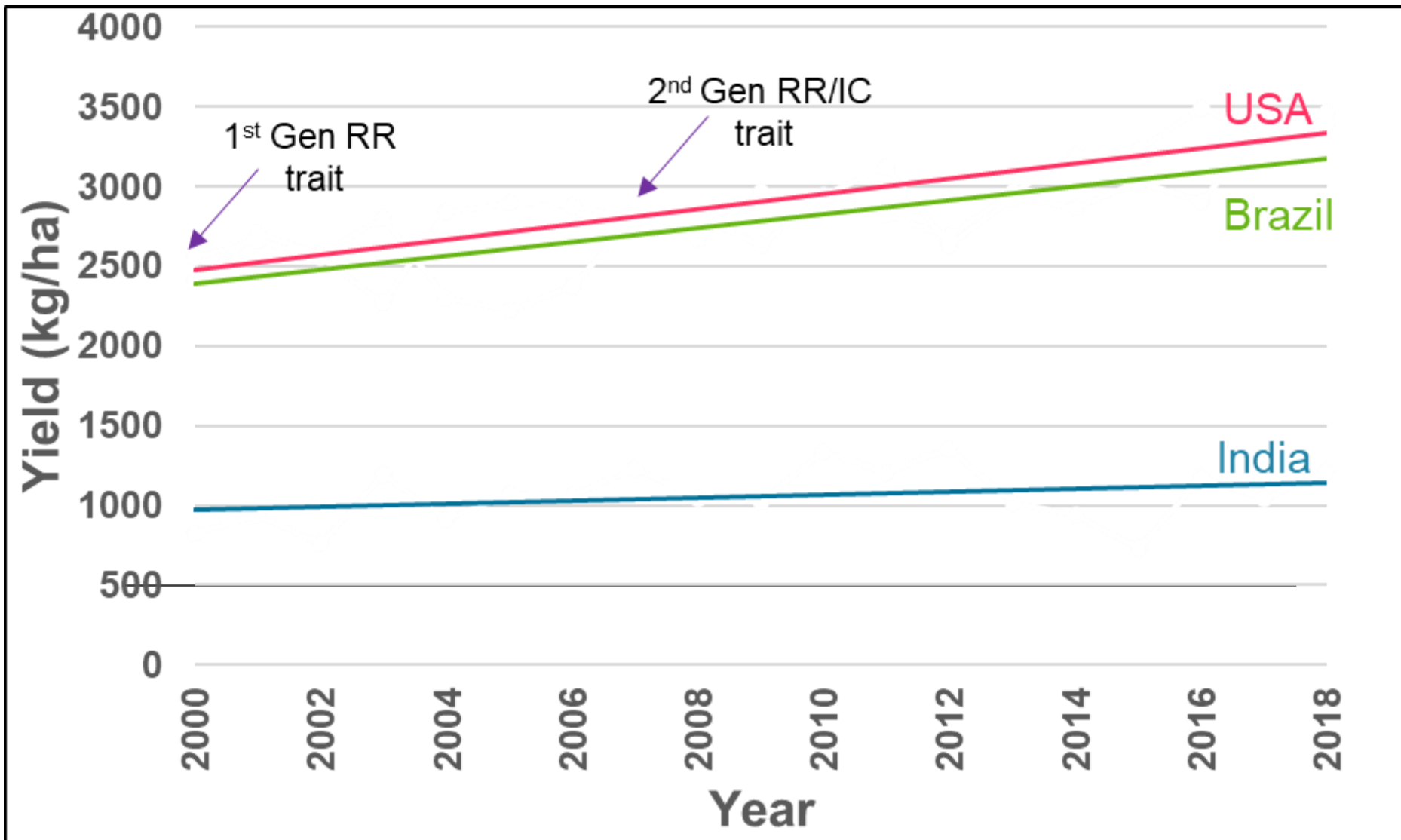


Trend in Soybean Yield in India, 1951-2021



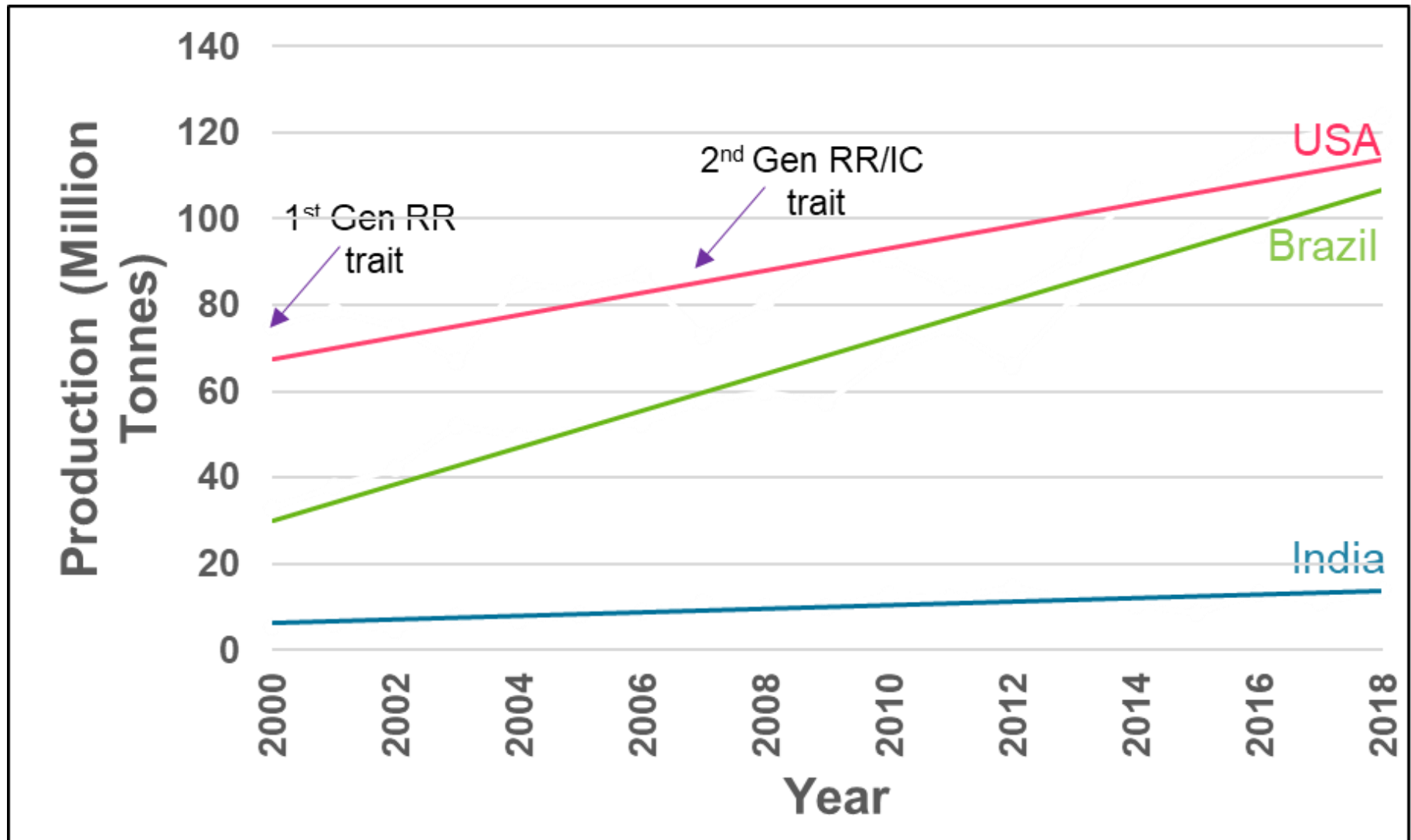
Source: Analyzed by SABC, 2021-22

Soybean Yield Trend in Brazil, India and US, 2020-21



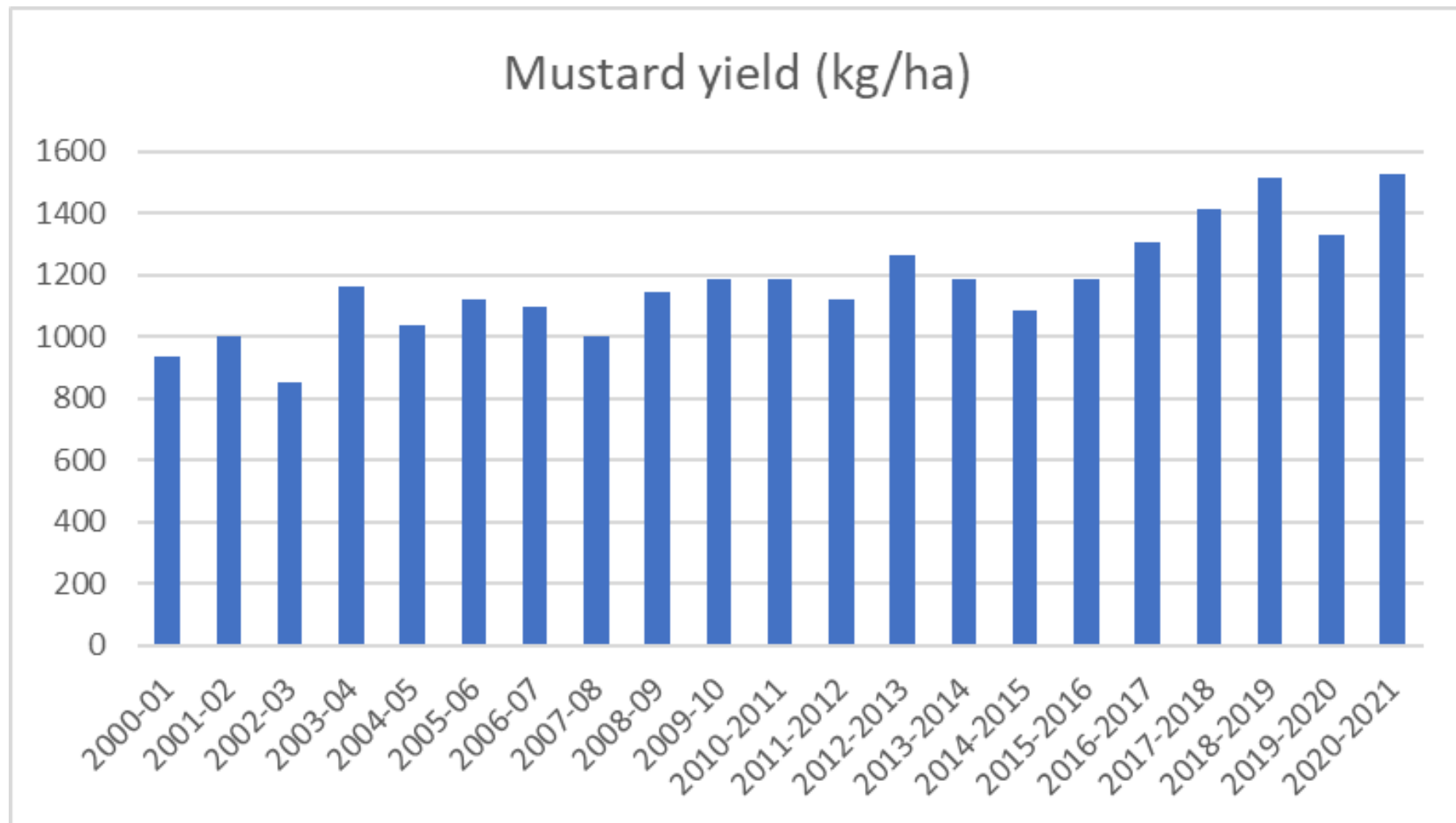
Source: Analyzed by SABC, 2021-22

Soybean Production Trend in Brazil, India and US, 2020-21



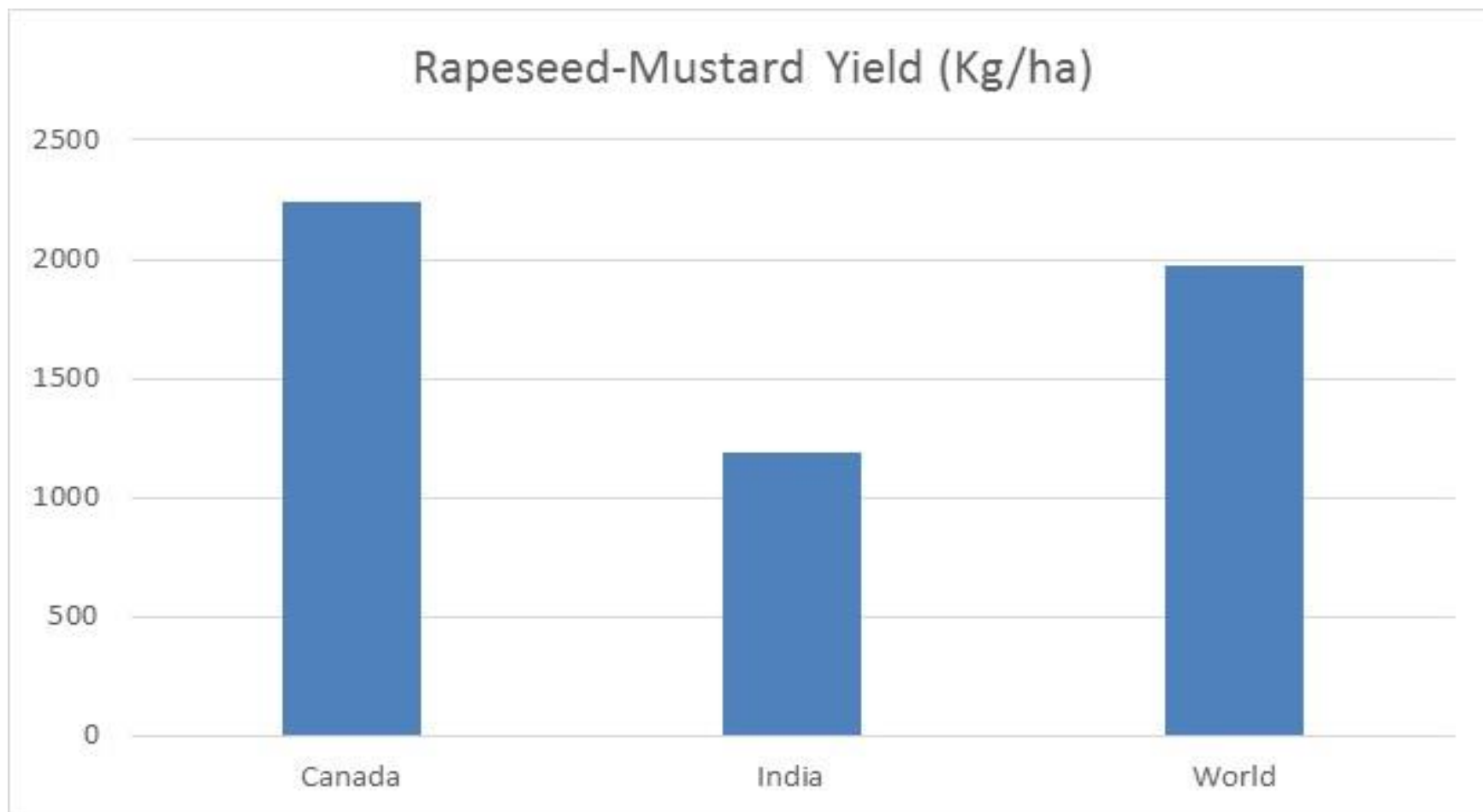
Source: Analyzed by SABC, 2021-22

Trend in Mustard Yield in India, 2001-2021



Source: Analyzed by SABC, 2021-22

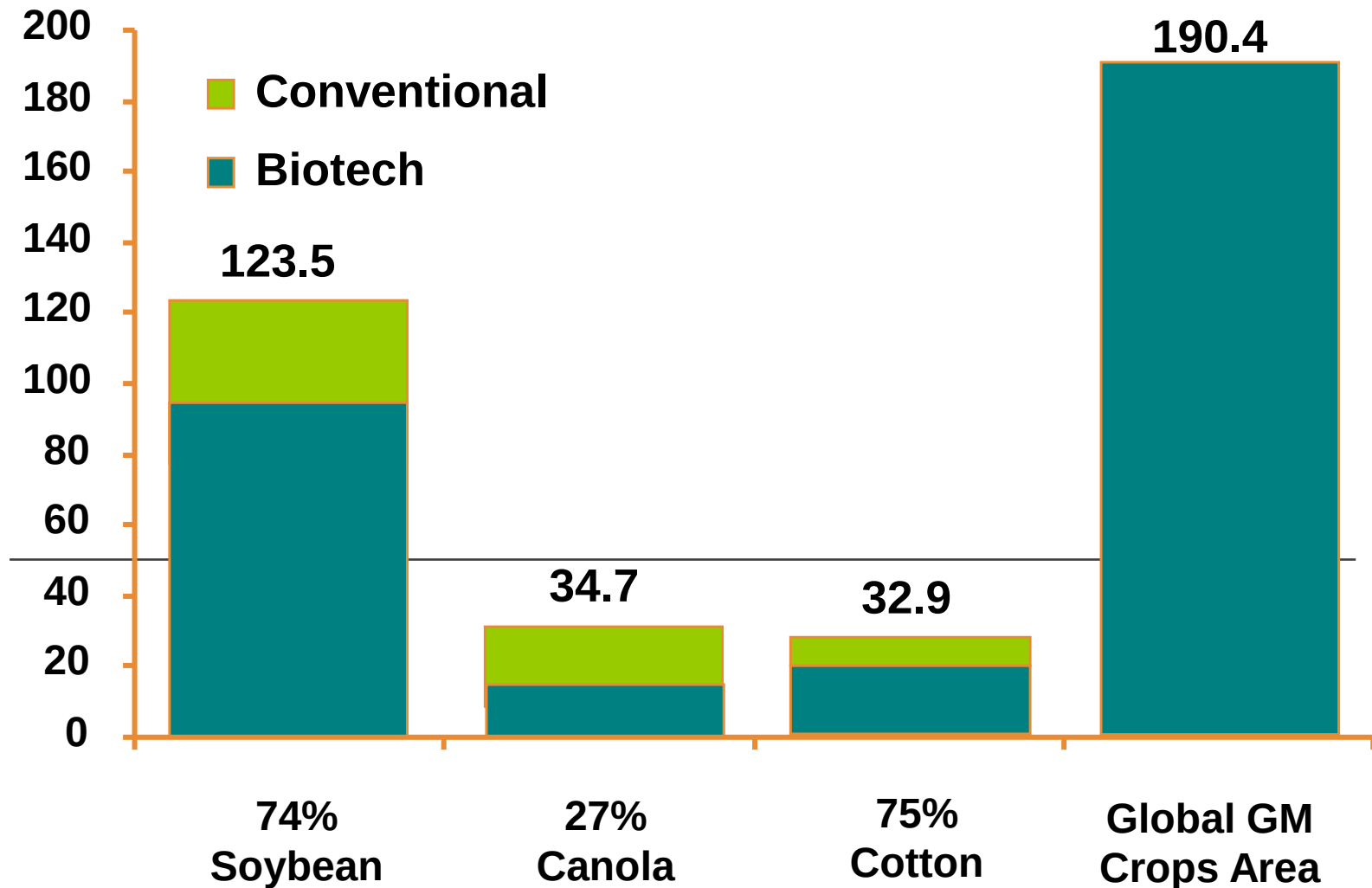
Yield Comparison of Rapeseeds-Mustard, 2021-22



Source: MOA&FW, 2021-22; Analyzed by SABC, 2021-22

Global Edible Oil Competitiveness

Global adoption of GM soybean and GM canola, 2019-20



Source: ISAAA, 2019-20 (Hectarage based on FAO data on 2019)

Brassica Breeding in India, 1989-2022

- Heterosis in oleiferous *Brassicas* recognized during 1940's
- CMS discovered - first in *B. napus* (*nap*, *pol*, *ogu*) and later in *B. juncea* (*tour*)
- Directed heterosis breeding efforts initiated in *B. juncea* during 1989
- First CMS based *B. napus* hybrid Qinyou No. 2 (*pol* CMS) was released during 1989
- Subsequently PGSH-51 by PAU, Ludhiana (*tour* CMS) released during 1994 in India
- Barnase barstar pollination control system breeding initiated in early 2000 at Delhi University
- DMH-1 & NRCHB-506 (Mori cyto) were released for commercial cultivation in Brassica juncea during 2008
- Bold-seeded high-yielding parental lines are being developed at both public and private sector in India

Development of hybrid system in mustard between 1989 to 2022

System	Types	Developer	Mustard hybrids	Year of development /release
Barnase-Barstar pollination control system	Genetic modification (GMO)	CGMCP, Delhi University	DMH-11	2000/2022
126-1 CMS	Conventional cytoplasmic male sterility (CMS)	CGMCP, Delhi University	DMH-1	2006
Moricandia arvensis CMS	Conventional cytoplasmic male sterility	ICAR	NRCHB-506	2008
Ogura-type CMS	Conventional cytoplasmic male sterility	Advanta/UPL & private seed companies	PSC 432/437	2010

Note: Data above is for Brassica juncea variety of mustard. CGMCP stands for Centre for Genetic Manipulation of Crop Plants. ICAR stands for Indian Council of Agricultural Research.

Source: *South Asia Biotechnology Centre, 2022*

GM Mustard –Function of Novel Gene(s)

Gene	Gene Source	Product	Function
Bar	Streptomyces hygroscopicus	phosphinothricin N-acetyltransferase (PAT) enzyme	Eliminates herbicidal activity of glufosinate (phosphinothricin) herbicides by acetylation
Barnase	Bacillus amyloliquefaciens	barnase ribonuclease (RNase) enzyme	Causes male sterility by interfering with RNA production in the tapetum cells of the anther
Barstar	Bacillus amyloliquefaciens	barnase ribonuclease inhibitor	Restores fertility by repressing the inhibitory effect of barnase on tapetum cells of the anther

Status of Commercial Approval of GE Canola (Brassica napus), 1996 to 2022

Trait/Stacked Trait(s)	Gene(s)/ Herbicide	Nos of Approved Events	Developers/ Trade Name	Commercial Approval	Approval for food and Feed Consumption
-Multiple Mode Herbicide Tolerance -Pollination Control System -Stacked Herbicide Tolerance & Pollination Control System -Modified Product Quality	Bar, Barnase & Barstar; Glyphosate; Glufosinate	35	-Bayer CropScience -Monsanto -Pioneer/ Dupont (InVigor; LibertyLink; Navigator; TruFlex; Roundup Ready)	Canada; USA; Australia	Australia; Canada; Chile; China; European Union; Japan; Malaysia; Mexico; New Zealand; Philippines; Singapore; South Africa; South Korea; Taiwan & USA

**Source: Analysed by South Asia Biotechnology Centre,
2022**

GM Mustard–Patents on modified barnase-barstar GM mustard owned jointly by India’s NDDB-Delhi University

Patent Title	Patent Nos	Countries
Regulation of lethal gene expression in plants.	6833494 2449250	USA/2004 Canada/2012
Method for producing insulator construct.	199542	India/2006
An insulator construct for controlling leaky expression of a lethal gene.	244022	India/2010
A method for obtaining improved fertility restorer lines for male sterile crop plants developed using transgenic approaches for hybrid seed production and a DNA construct for use in said method.	7741541 1644506 238973	USA/2010 EU/2009 India/2010
A new cytoplasmic male sterility for Brassica species and its use for hybrid seed production in Indian oilseed mustard Brassica juncea (filed & obtained in USA, Canada, Australia and India).	2005276075 8,030548 B2 2,578,187	Australia/2005 USA/2011 Canada/2015

GOVERNMENT SUPPORT TO EO SECTOR

- **Technology mission in 1980, now converted to National Mission on Oilseeds and Oil Palm (NMOOP) since 2014.**
- **This helped increased production from 11.3 MT in 1986-87 to 26.68 MT in 1914-15 and 28 million tons by 2021-22.**
- **Greater freedom to open market and allow healthy competition.**
- **Flexible export-import policy to harmonize interest of all stakeholders, regulate import duty structure.**
- **Launching of National Mission on Edible Oils - Oil Palm (NMEO-OP) in 2021**
- **Expected to launch National Mission on Edible Oils - Oilseeds (NMEO-OS) in 2023**

STRATEGIES FOR IMPROVING PRODUCTIVITY

- Enhancing water use efficiency through hydrophilic polymers, micro-irrigation and weed management.
- Intensification of R&D for improving genetic pool, identification and introgression of useful traits using genetic modification and genome editing tools for imparting biotic and abiotic stresses
- Replacing low yielding species of *Eruca sativa*/*Brassica carinata* etc with high yielding *Brassica juncea*
- Deploying TRIPLE M Cropping System (Maize, mustard and moongbean) to complement Rice Wheat Cropping system, identifying & replacing low yielding rice-wheat geographical areas with assured MSP and procurement of TRIPLE M (maize, mustard and moong bean)

STRATEGIES FOR IMPROVING PRODUCTIVITY

- Expanding cultivation of soybean in Northern zone, and resurrecting sunflower areas
- Along with pulses, in Rabi season many crops like linseed, groundnut, safflower, niger etc can occupy some of 12 million ha rice fallow area.
- Development of site specific INM, IPM and inter-sequential cropping practices.
- Development of special quality oils, high oleic groundnut, confectionary nuts of sunflower, high yielding zero erucic and double zero mustard and double purpose linseed.
- Custom-hiring for mechanization of cultivation

Summing Up Edible Oil Conundrum

- **Research Approach:** Yield improvement through MAS, Transgenic, Genome Editing, Double Haploid and Use of hybrids technology. Systematic crop specific R&D approach, improve grain and oil yield, efficient weed management & pests and disease tolerance
- **Developmental Approach:** Deploy new cropping system such as TRIPLE M, expanding Soybean & Sunflower in strategic areas, reduce yield gap (potential-realizable yield) and scientific outreach
- **Policy Interventions:** MSP based procurement policy, long term strategic policy on import (refined vs crude), national campaign on edible oil intake and public private partnership involving upstream and downstream industry



**For partnership with SABC,
contact : charumayee@sabc.asia**