



National Conference on Globalization of India's Crop Improvement Research

Seed Technologies And Policies That Can Substantially Help Export of India's Seed

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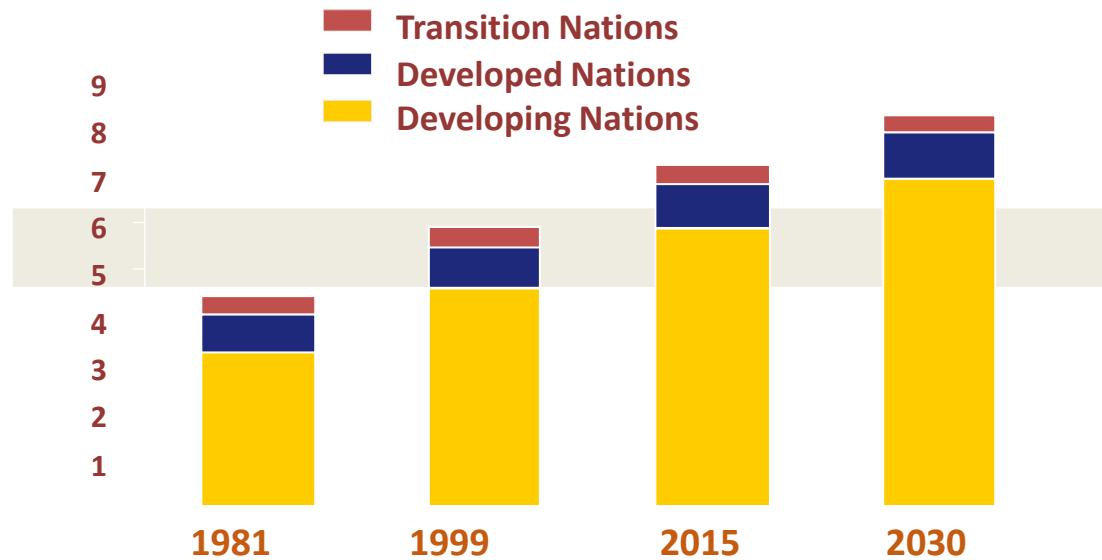
Director

ICAR-Indian Institute of Seed Science, Mau

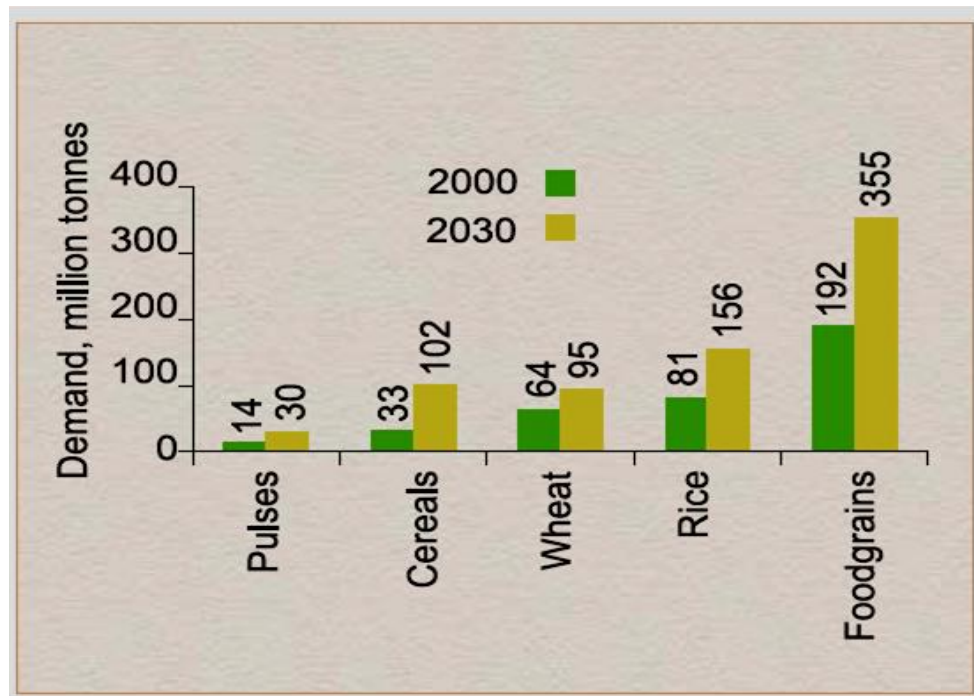
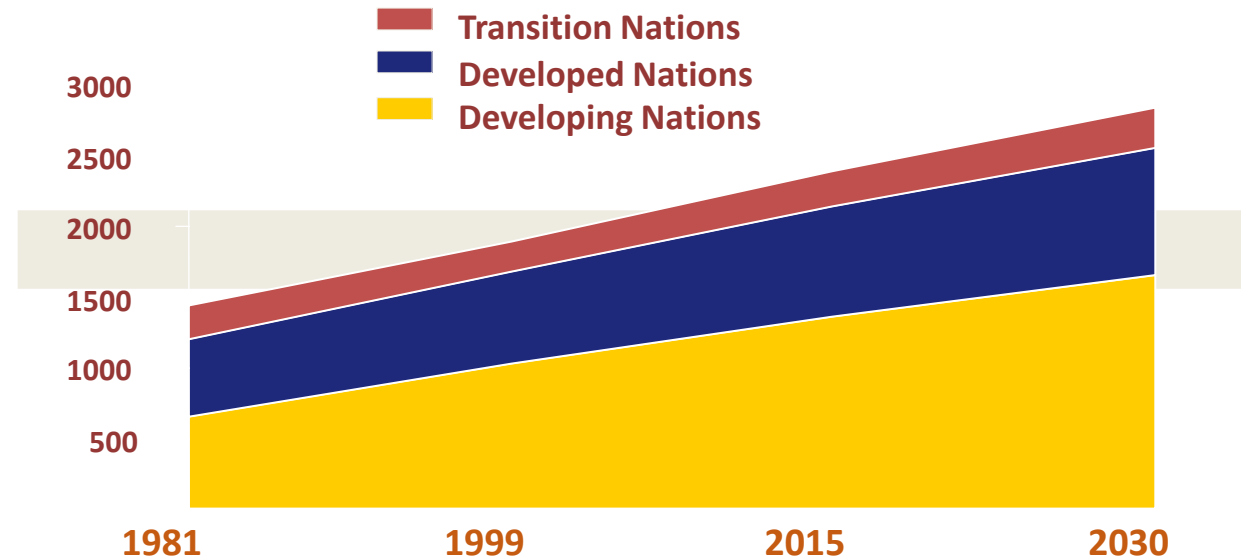
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Growing World Population (B)



Rising Cereal Demand (MMT)



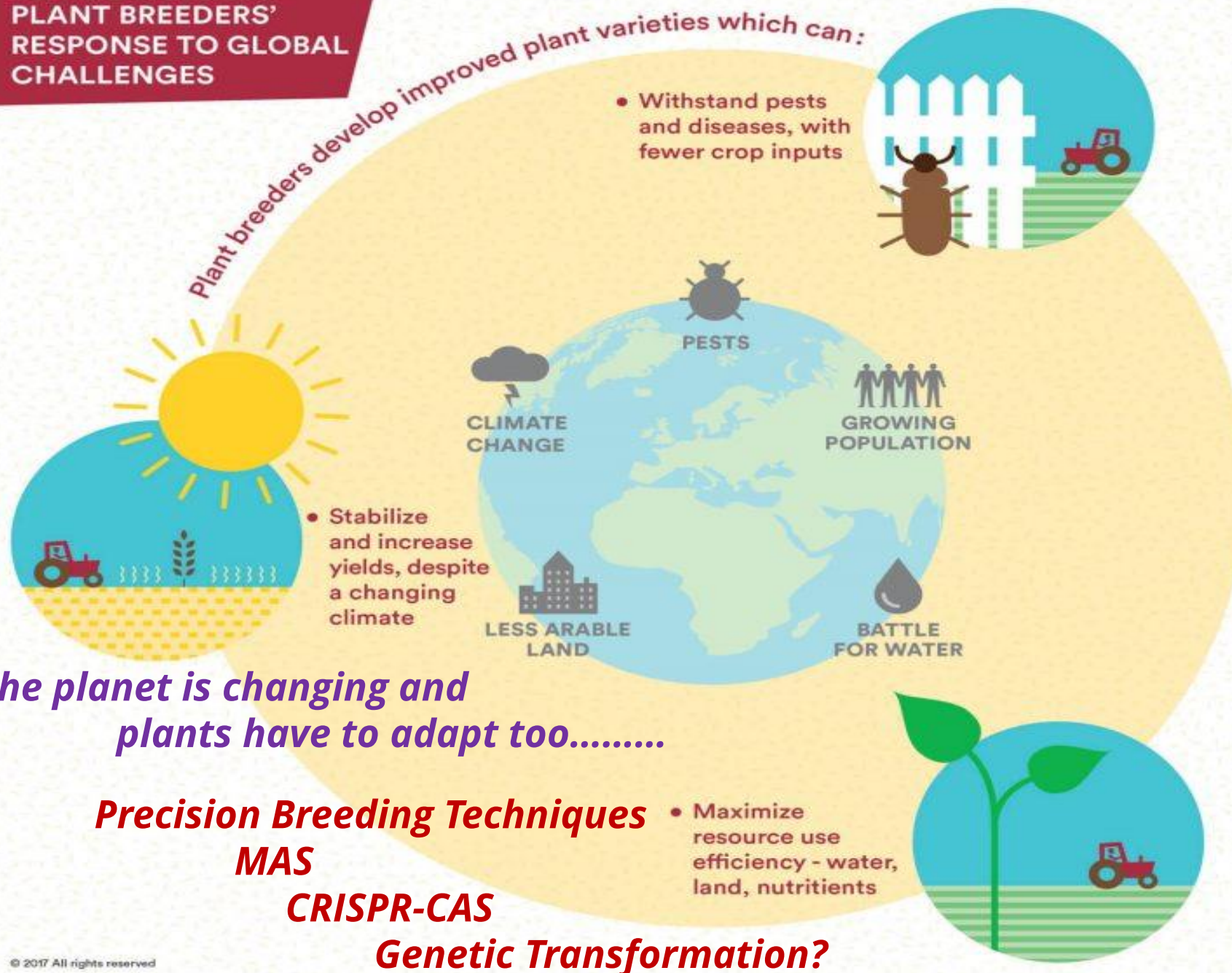
By 2050 world's population will be 8.8 billion. Urban population shall move up from 50 to 70 %.

Arable acreage will not increase, i.e. same fields must produce 70 % more.

--- Hence at input level, one of the solution might be seed.

We need seed

PLANT BREEDERS' RESPONSE TO GLOBAL CHALLENGES



CLIMATE CHANGE

2016 **14.7 °C** ↗ 2050 **16.0 °C**
Increase of average global temperature

PESTS

2016 **10-15 %** ↗ 2050 **20-25 %**
Increase in the amount of global crop production lost to pests

BATTLE FOR WATER

2016 **3,500 km³** ↗ 2050 **5,500 km³**
Rise of global water demand

GROWING POPULATION

2016 **7.3 bn** ↗ 2050 **8.8 bn**
Rise of global population

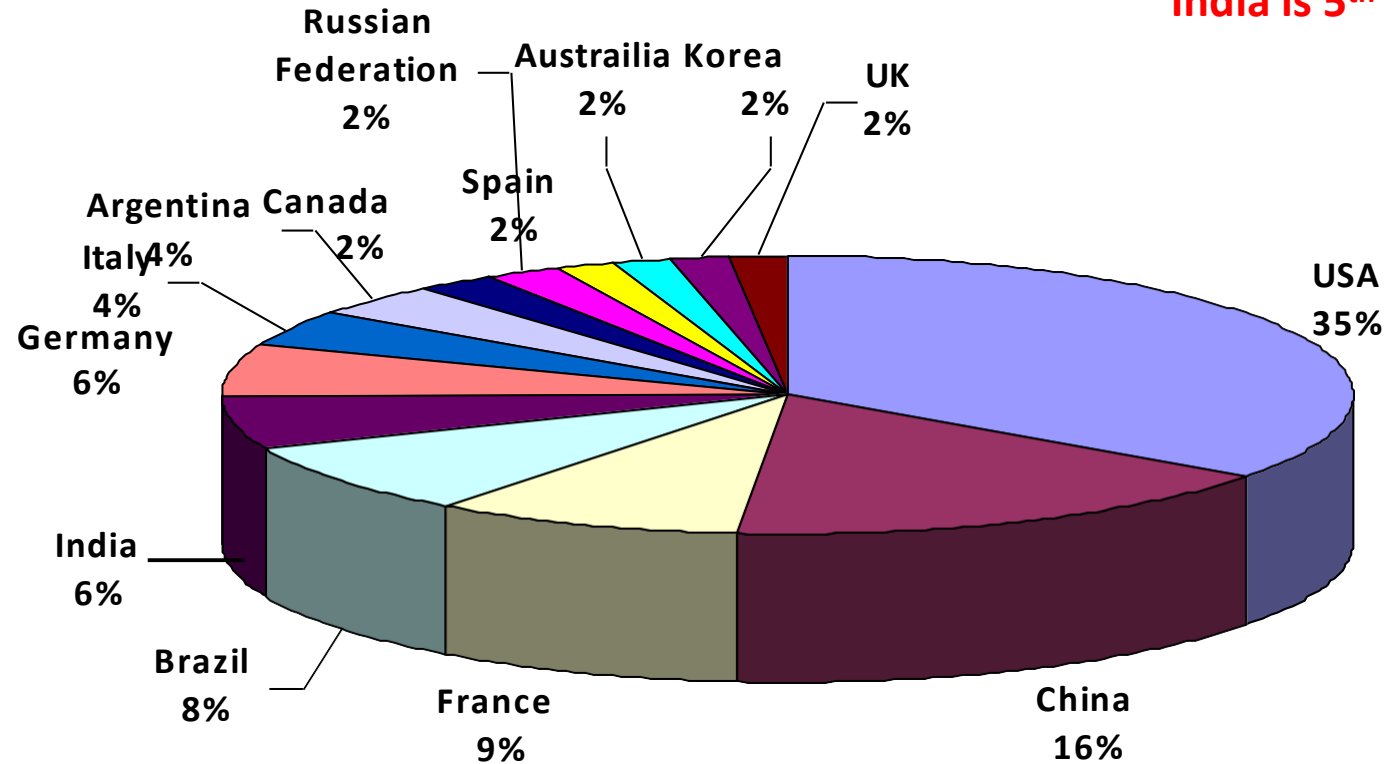
LESS ARABLE LAND

2016 **0.20 ha** ↘ 2050 **0.15 ha**
Decrease in use per capita

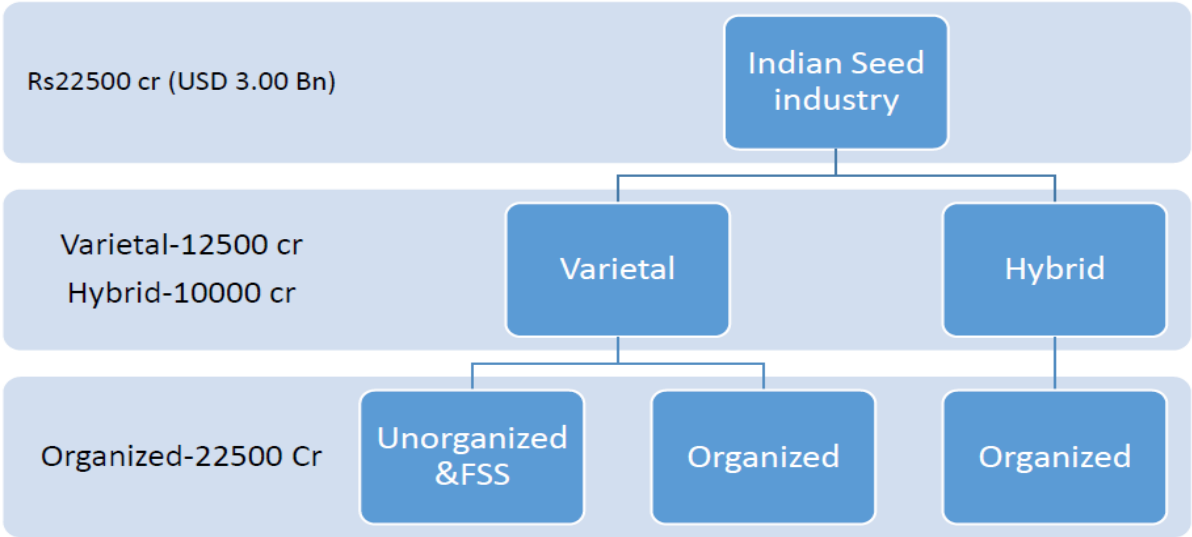
Major global players in seed production

Global commercial domestic seed market is ~ US\$ 60 billion

India is 5th largest Global Seed Economy



Indian Seed Domain



Source: NSAI Reports

Public seed sector

Commercial Seed Production

National Seed Corporation

25 State Seed Corporations

Research

51/114 ICAR research institutes

73 Agricultural Universities (SAUs, CAUs & DUs)

Private seed sector

Seed Production & Research

~ 50 large national & Multinational player

~ 500 small & medium players

Quality Assurance

- Around 145 notified seed testing laboratories (8 ISTA accredited and 20 ISTA membership)
- One Central Seed Testing Laboratory
- One Referral Laboratory for testing Bt- cotton seeds (ICAR-CICR, Nagpur)

The flowchart illustrates the seed production and distribution system in India, showing the flow from the Government of India (DAC) to State Governments (SSC, NSC, SFCI, SAI etc.) and ICAR Institutes & SAUs, and then to ICAR, HISS*, Distributors, Agencies, and finally to Farmers.

Key Components and Flow:

- Government of India (DAC):** Issues an **Indent of Breeder seed** to State Governments and **Lifting of Breeder seed** from ICAR Institutes & SAUs. It also provides **Allotment for production** to ICAR.
- ICAR Institutes & SAUs:** Produce **Production of Breeder seed** and provide **Allotment for production** to ICAR.
- ICAR:** Provides **Allocation for production** to State Governments and **Production of Breeder seed** to ICAR. It also provides **Certified seed distribution** to Distributors.
- State Governments (SSC, NSC, SFCI, SAI etc.):** Provide **Allotment of Breeder seed** to ICAR and **Foundation seed production** to Agencies. They also undertake **Seed Multiplication Ratio (SMR) and Seed Replacement Rate (SRR)**.
- Agencies:** Provide **Foundation seed to Certified seed** to ICAR and **Certified seed production** to State Governments.
- Distributors:** Receive **Certified seed distribution** from ICAR and provide **Certified seed production** to State Governments.
- Farmers:** Receive **Certified seed production** from State Governments.

Seed Multiplication Ratio (SMR) and Seed Replacement Rate (SRR) undertaken by States

* Indian Institute of Seed Science, Mau: Coordination unit for Breeder Seed Production



Status of varietal release in the country

Crops	No. of varieties released and notified during 2014-22									Grand total
	ICAR Institutes			SAUs			Private Sector			
	Central	State	Total	Central	State	Total	Central	State	Total	
Rice	84	52	136	57	191	248	40	18	58	442
Wheat + Barley	53	11	64	37	45	82	0	0	0	146
Maize	34	4	38	21	40	61	47	8	55	154
Sorghum	9	0	9	11	25	36	7	0	7	52
Pearl millet	2	1	3	8	16	24	25	7	32	59
Other millets	5	5	10	23	38	61	0	0	0	71
Oilseeds	33	6	39	103	134	237	4	11	15	291
Pulses	41	31	72	81	151	232	0	0	0	304
Com. crops	46	1	47	80	23	103	88	1	89	239
Forages	18	3	21	62	33	95	2	0	2	118
Sugarcane	20	3	23	16	25	41	0	0	0	64
Others	5	0	5	6	5	11	0	0	0	16
Total	350	117	467	505	726	1231	213	45	258	1956
% of total			23.88			62.93			13.19	

- **It includes 87 bio-fortified crop cultivars** like rice (8), wheat (28), maize (14), pearl millet (9), finger millet (3), small millet (1), lentil (2), groundnut (2), linseed (1), mustard (6), soybean (5), cauliflower (1), potato (2), sweet potato (2), greater yam (2) and pomegranate (1).
- These cultivars have been improved for essential nutrients viz., iron, zinc, calcium, protein, lysine, tryptophan, provitamin-A, anthocyanin, vitamin-C, oleic acid and linoleic acid.

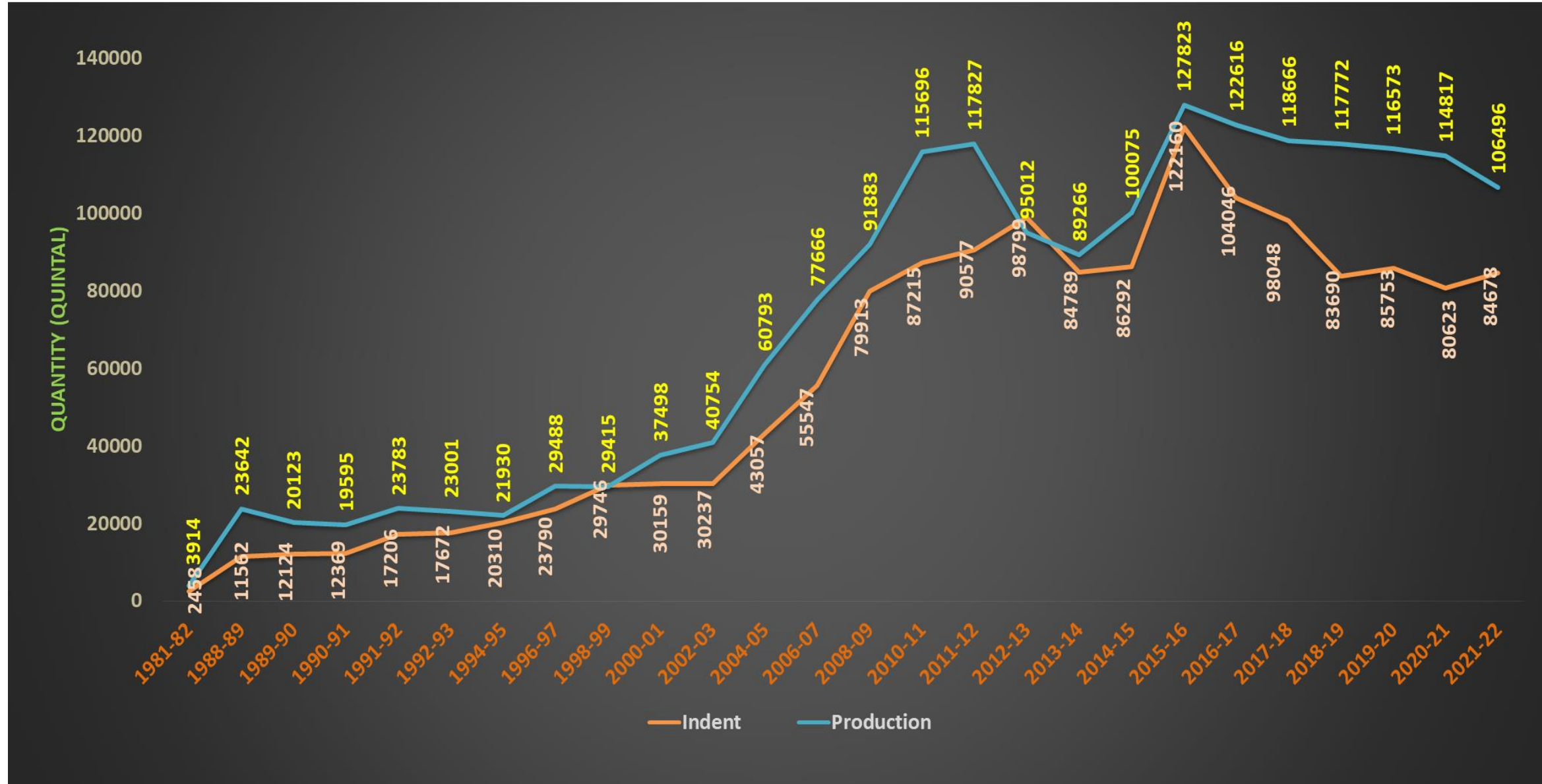
..... *there is a strong correlation between quality seed availability and yield per se*

Seed Security & Food Security

Period	Quality/Certified seed availability (lakh quintal)	Food grain production (million t)	Oilseed Production (million t)	Pulse Production (million t)
1980-81	35.00	129.59	9.37	10.63
1990-91	57.00	176.39	18.61	14.26
2000-01	85.00	196.81	18.44	11.08
2009-10	279.72	218.10	24.90	14.70
2011-12	353.62	259.29	29.80	17.09
2012-13	328.52	257.13	30.94	18.34
2013-14	332.84	265.05	32.75	19.25
2014-15	351.77	252.03	27.51	17.15
2015-16	343.52	251.54	25.25	16.32
2016-17	380.34	275.11	31.28	23.13
2017-18	419.41	285.01	31.45	25.41
2018-19	398.87	285.21	31.52	22.15
2019-20	431.01	297.50	33.22	23.03
2020-21	483.66	310.74	35.95	25.46
2021-22	498.83	315.72	37.69	27.69

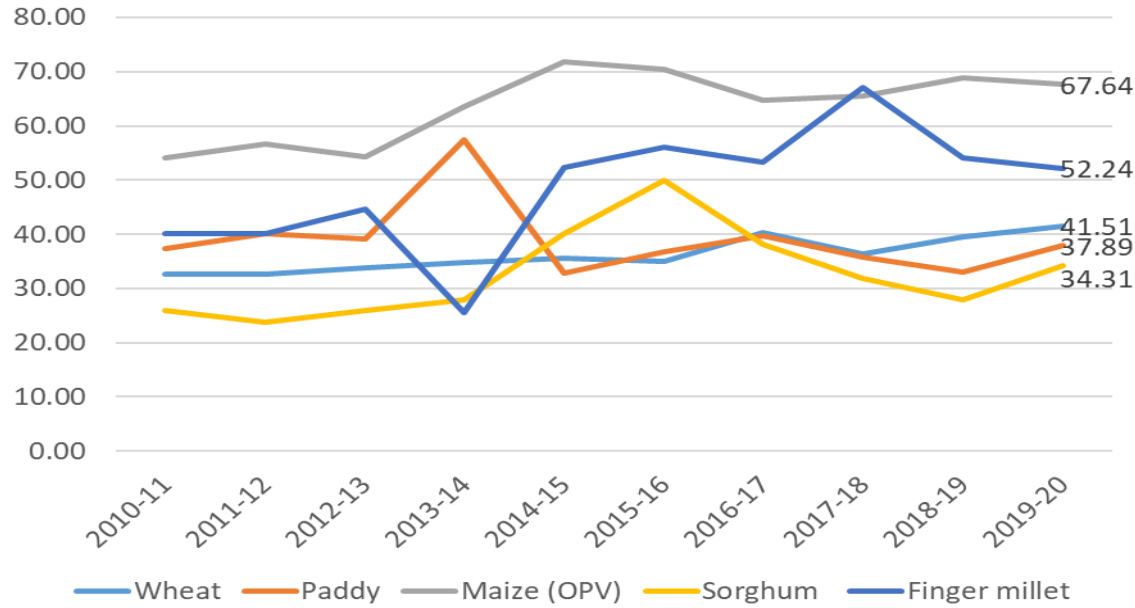


Trends in Breeder Seed Production

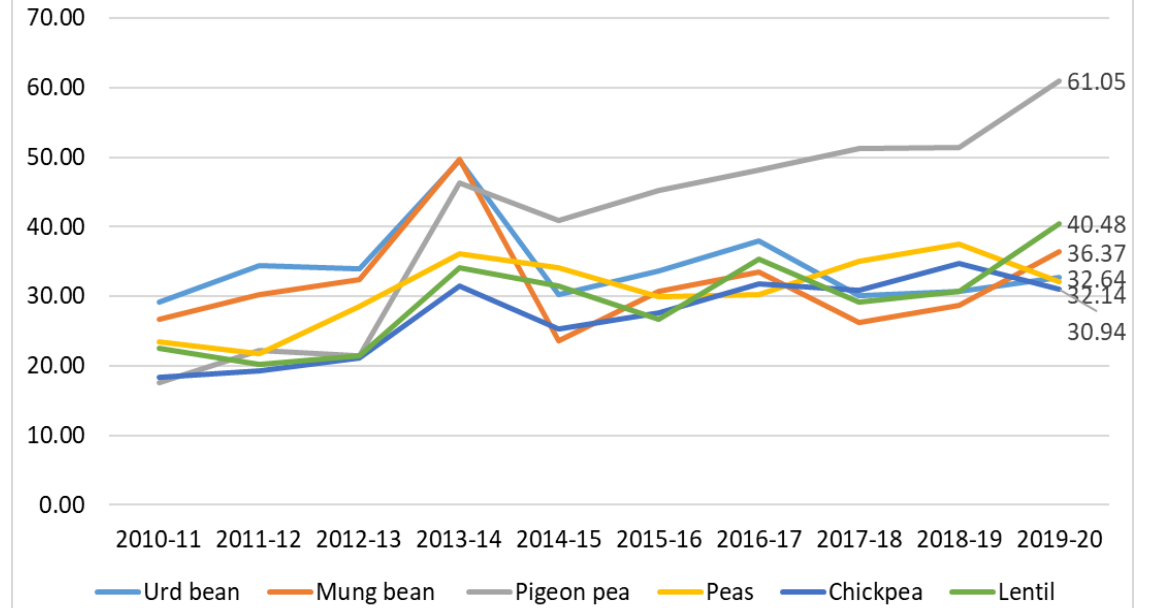


National Seed Replacement Rate (SRR)

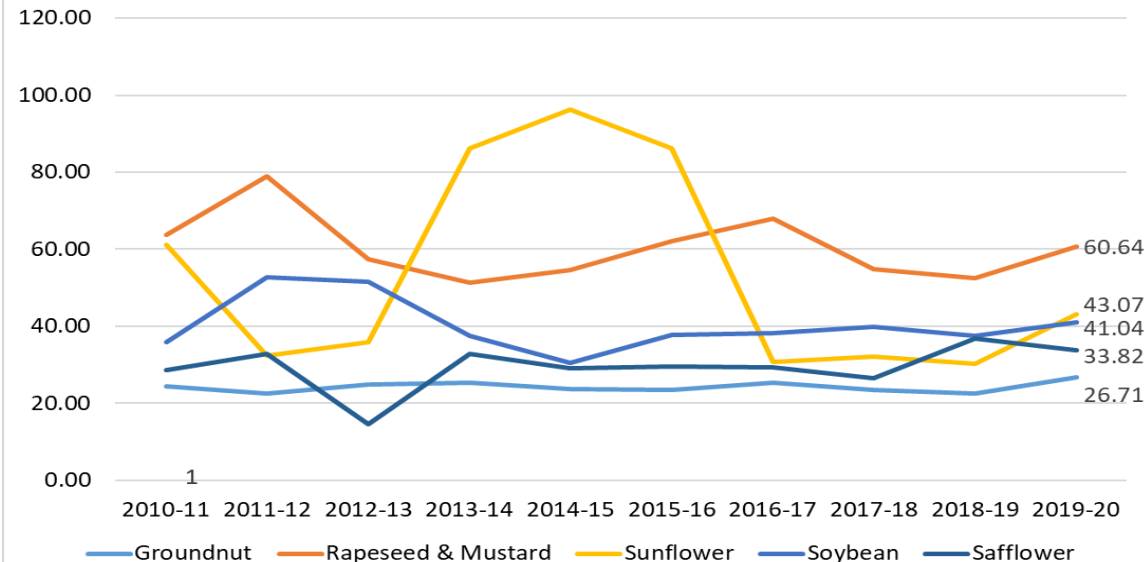
Cereals



Pulses



Oilseeds



Desired SRR as per National Seed Policy, 2002

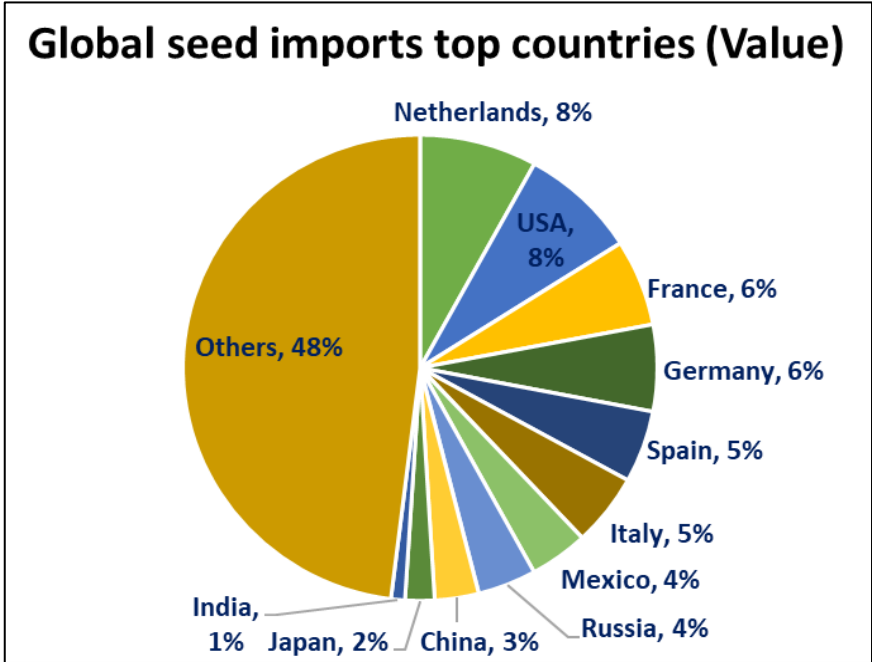
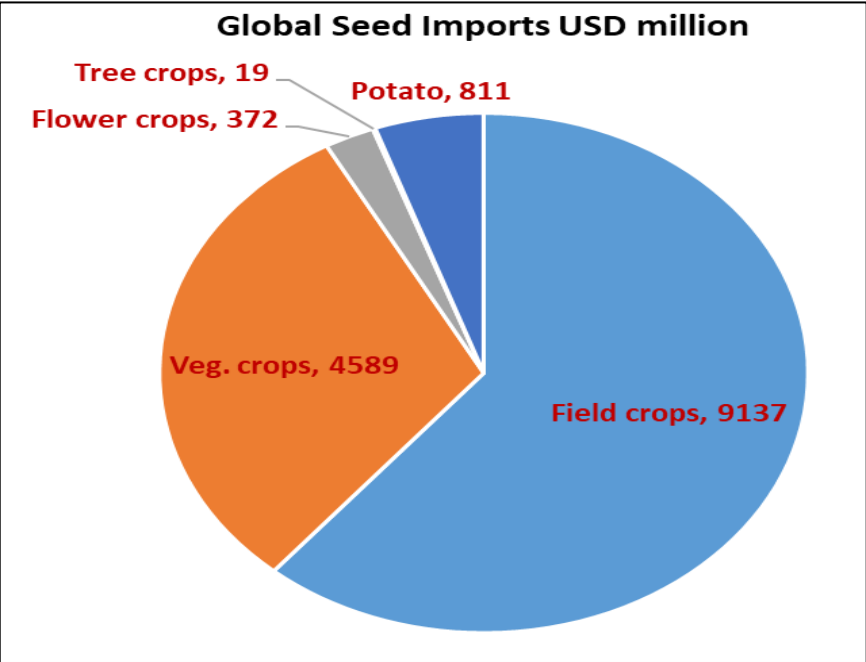
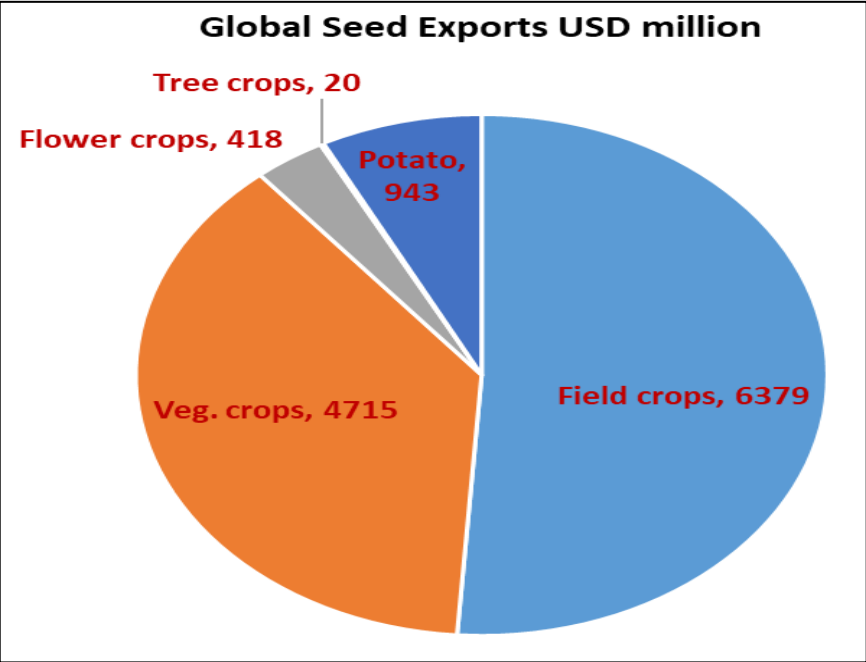
- Self Pollinated- 35 %
- Cross pollinated- 50 %

Regional imbalance exists

- Odisha, Jharkhand, Bihar shows poor SRR

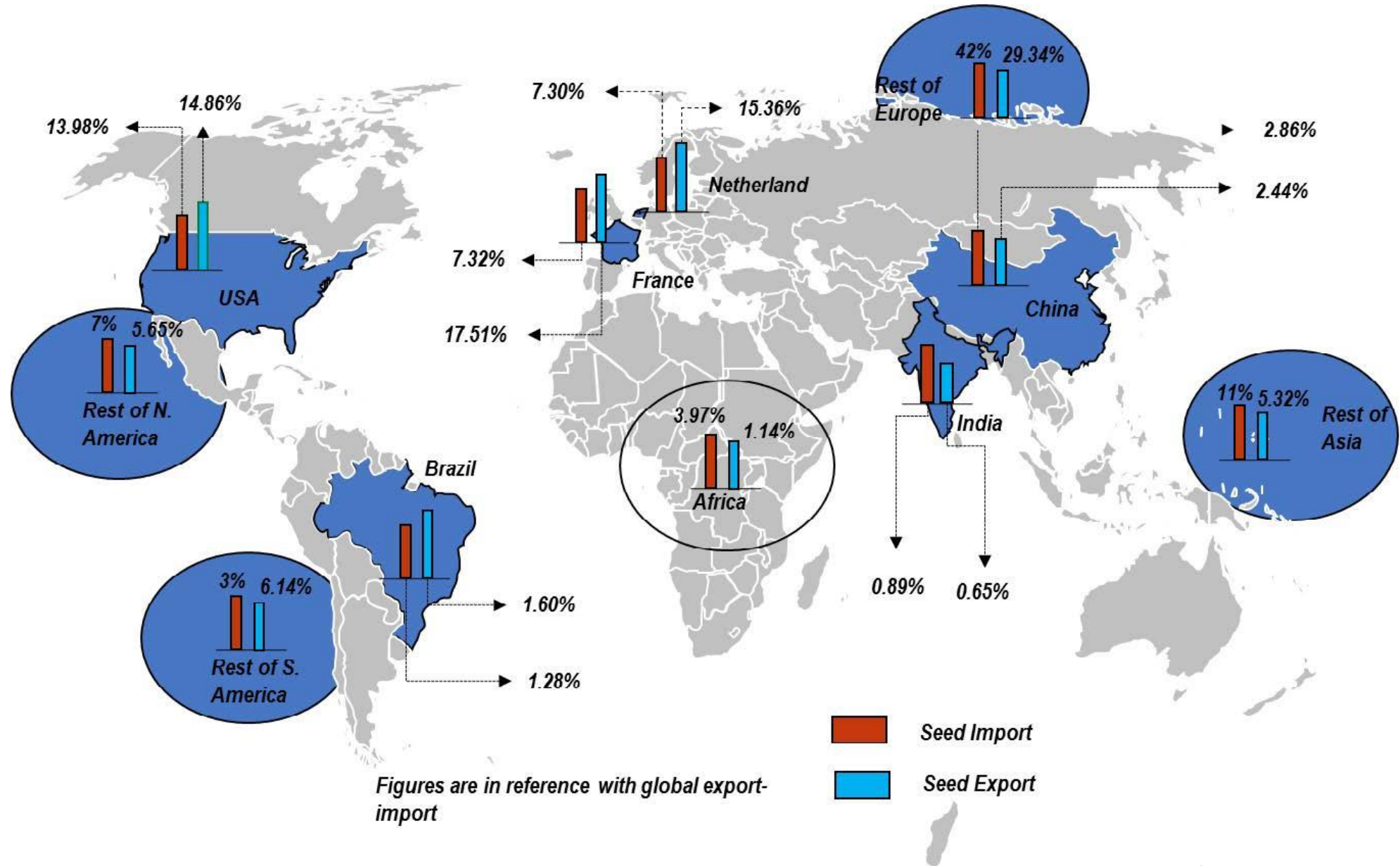
Source: Seed Division, DA&FW, GoI

Global Seed Exports-Imports 2020



Source: ISF, 2020

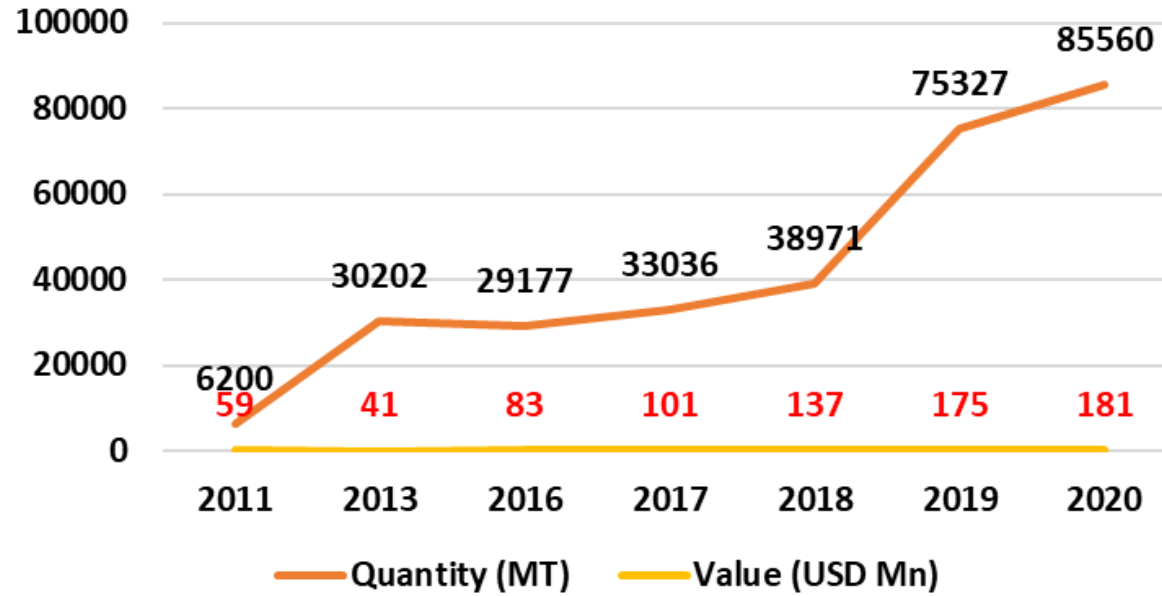
Major Export Import Markets



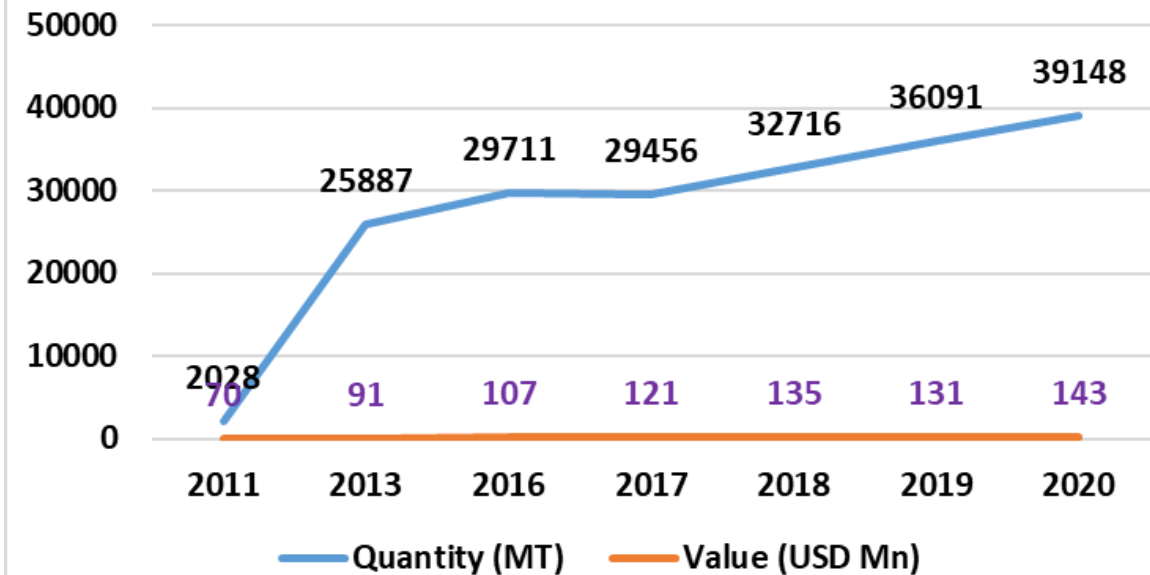
Source: NSAI-Sathguru Reports

Indian Seed Exports-Imports 2020

Indian Total Seed Exports



Indian Total Seed Imports



Seed Exports: Share of India (2020)

Country	Quantity (metric tonnes)				Value (USD Million)			
	Veg. Crops	Flowers	Field crops	Total	Veg. Crops	Flowers	Field crops	Total
Global	145312	6762	5410337	7264795	4715	418	9754	15850
India	20411	148	65001	85560	97	2	82	181
% Share	14	2	1	1	2	0.5	0.8	1

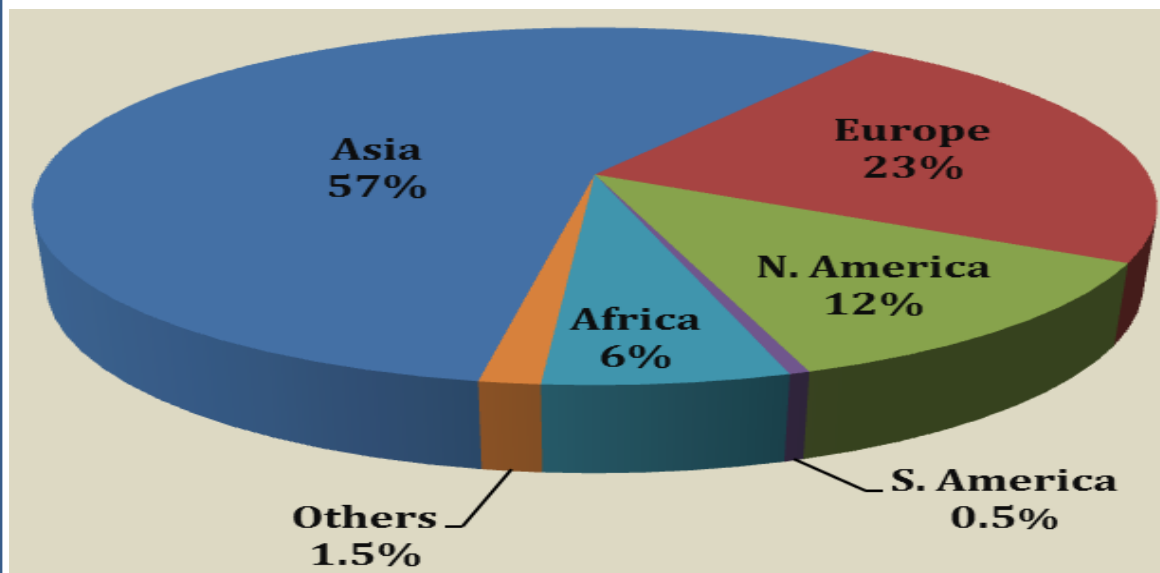
Seed Imports: Share of India (2020)

Country	Quantity (metric tonnes)				Value (USD Million)			
	Veg. Crops	Flowers	Field crops	Total	Veg. Crops	Flowers	Field crops	Total
Global	158095	9084	5869880	7502058	4589	372	9137	14928
India	10125	23	29000	39148	95	10	38	143
% Share	6.4	0.3	0.5	0.5	2	2.7	0.4	0.95

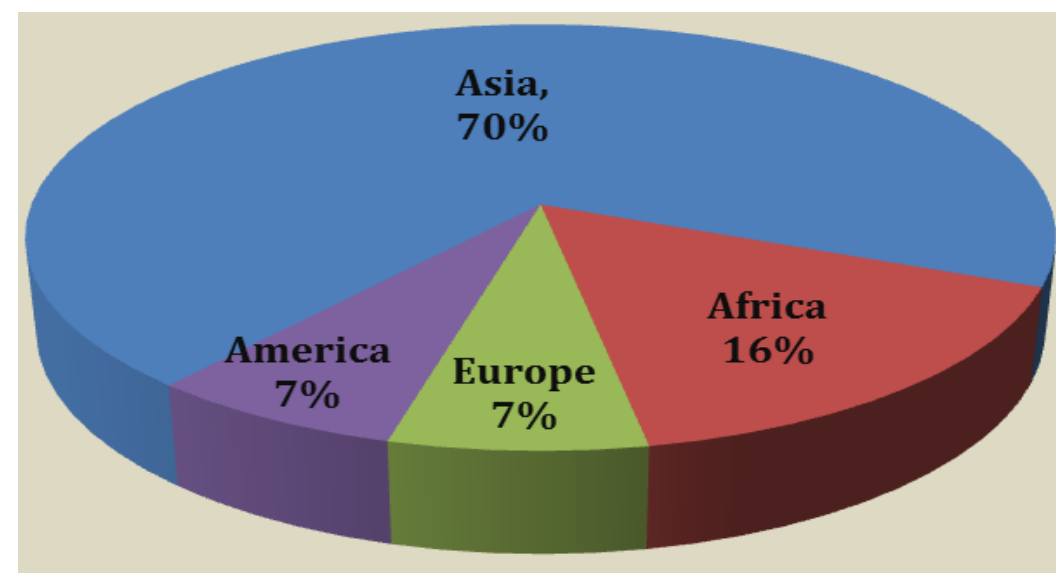
Source: International Seed Federation, 2020

Top Seed Export Destination in World (Value)

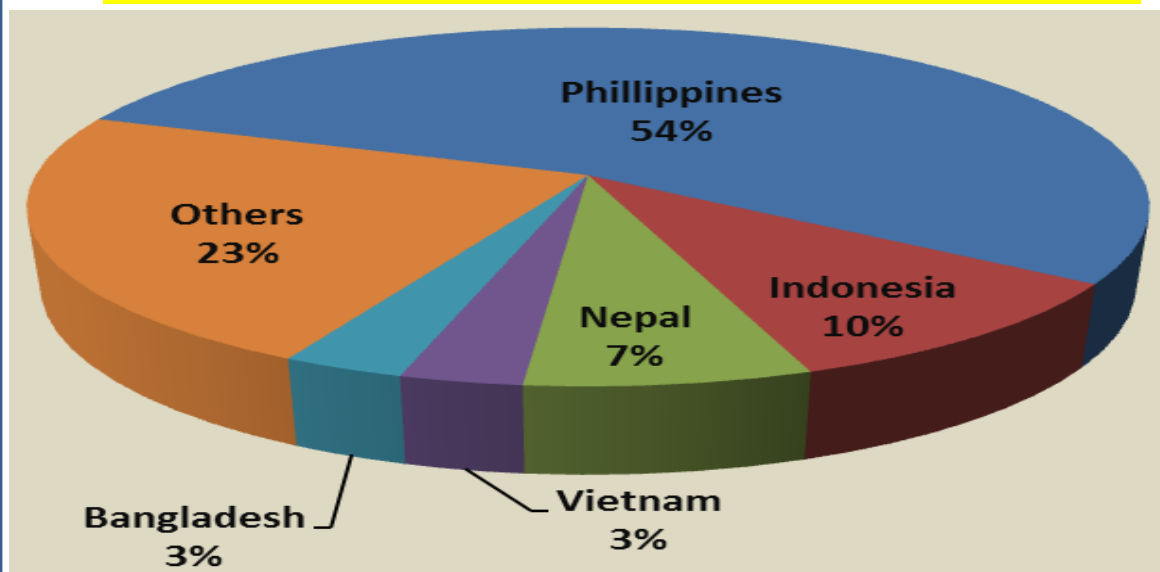
Vegetable Crops Seed



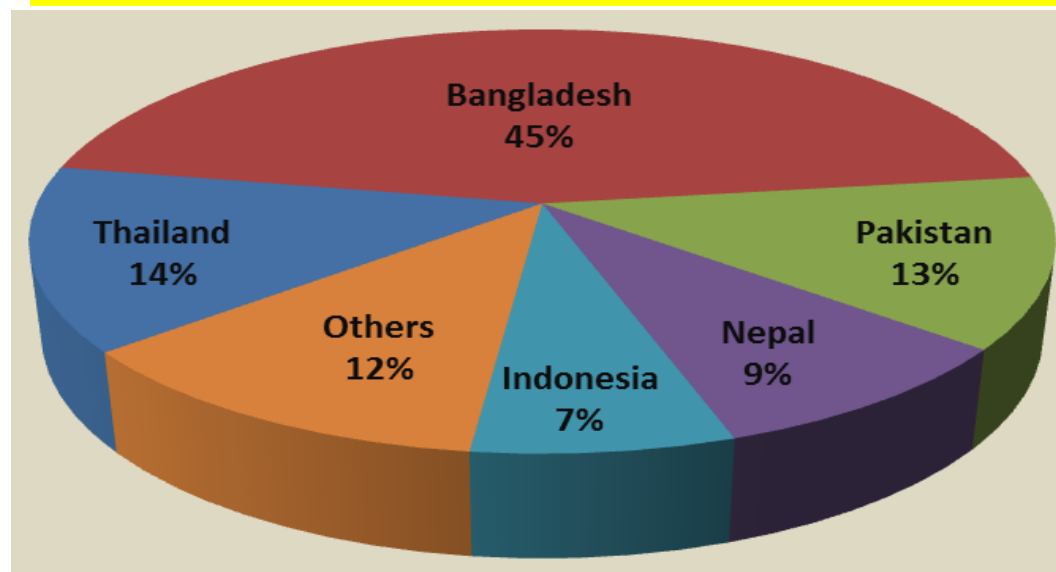
Field Crops Seed



ASEAN market top export destinations (Value) for India

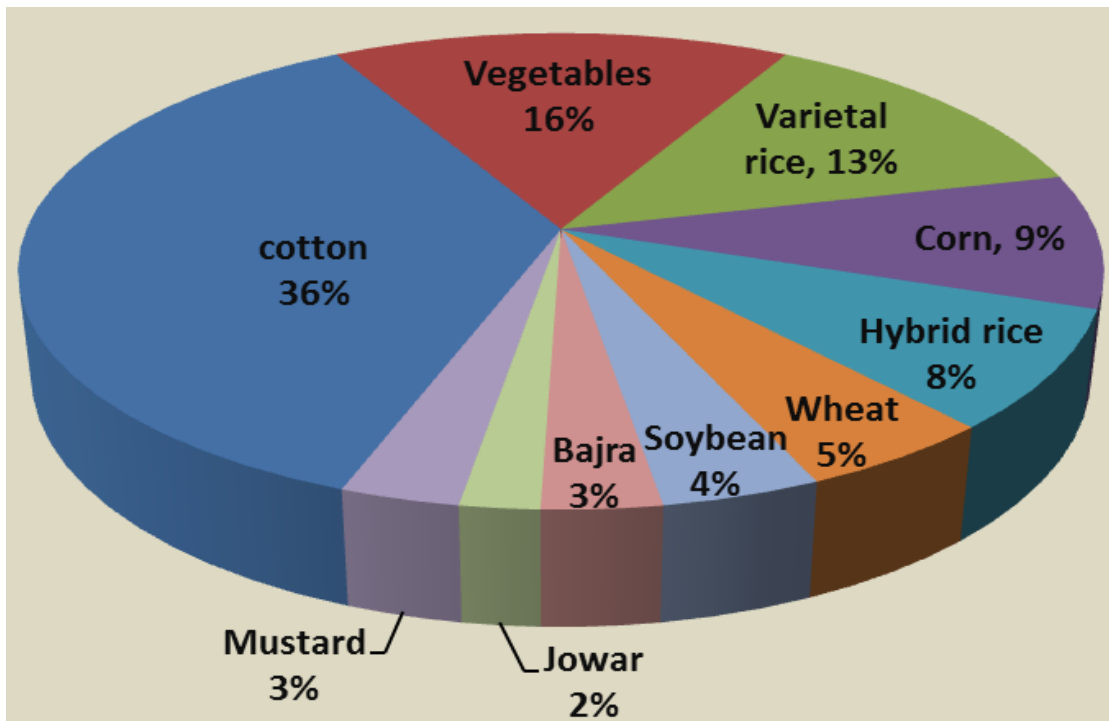


SAARC market top export destinations (Value) for India

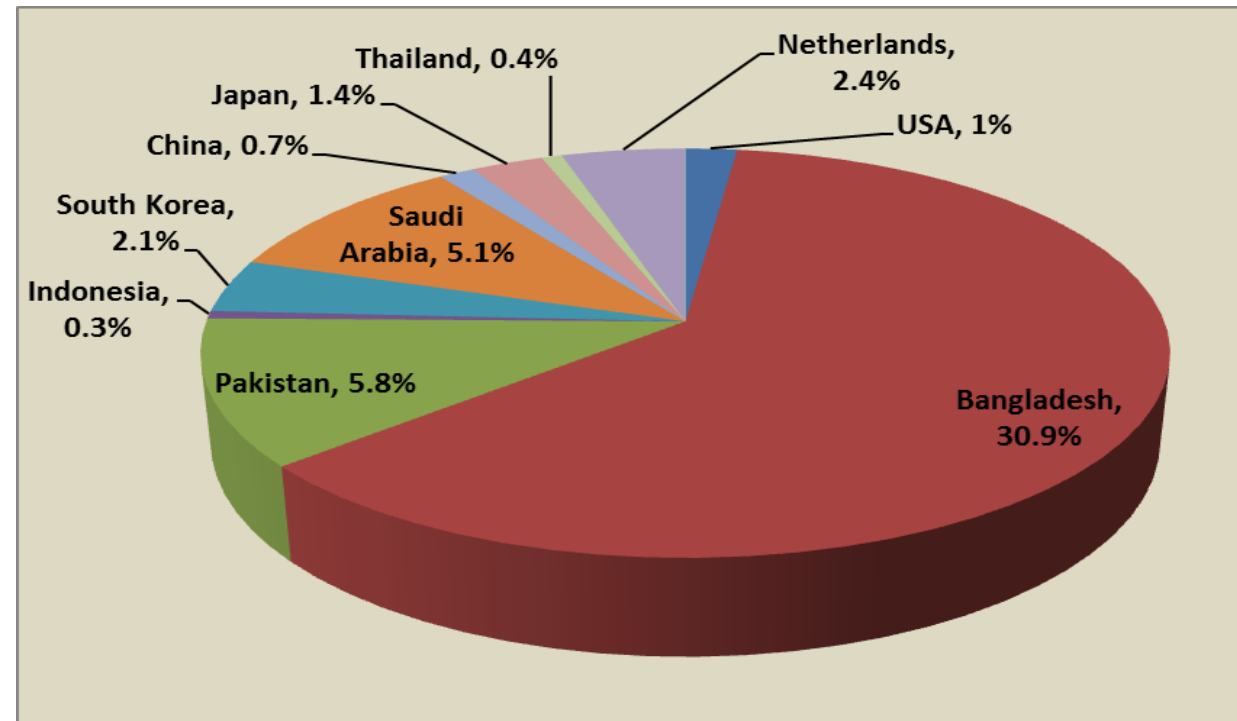


Source: Seed Times, NSAI

Leading crop segments in export (Value) from India



Country wise export share (value) of vegetable seed from India



- ✓ Africa majorly importing seeds from U.S. & Europe- not performing well because of tropical climate
- ✓ Indian seed industry need to explore
 - Africa-Kenya, Zambia, South Africa, Zimbabwe, Tanzania, Ethiopia & some East African countries (Sorghum, Bajra, Rice, Maize, Cotton, Sunflower and Vegetables)
 - SAARC- region has huge potential market; germplasm adaptable in Punjab and West Bengal easily adapts in Pakistan and Bangladesh

World Seed Partnership

An ISF-ISTA-OECD-UPOV-WFO Initiative



To support the development of the seed sector in countries around the world.

Making sure that farmers have access to high quality seed and suitable new plant varieties

OECD Seed Schemes for Varietal Certification

Eight Agricultural Seed Schemes (2022-23)

1. Grass and Legume Seed Scheme
2. Seed Scheme for Crucifers and other Oil and Fibre Species
3. Cereal Seed Scheme
4. Maize Seed Scheme
5. Sorghum Seed Scheme
6. Vegetable Seed Scheme
7. Sugar and Fodder Beet Seed Scheme
8. Seed Scheme for Subterranean Clover and Similar Species

India participate in six
seed schemes

- 61 member countries participate in OECD Seed Schemes (over 50000 varieties in 204 crop species)
- India is participating in 6 seed schemes (259 varieties in 20 crops)

The OECD Seed Schemes

Harmonized rules for varietal identity and seed certification

Facilitate movement of high quality seeds in domestic production and export markets

OECD Seed Schemes: Global Fact Sheet

- During 2019-20, 1035000 MT of certified seed in field crops produced under OECD Seed Scheme
- Roughly 28% of global seed exports
- Three biggest producers are France, Italy and USA

- Top three species were wheat, maize and sunflower. There has been limited variation in the leading species in the last five years.

- 347 million Kg of wheat seed was certified in 2019-20.
- Iran was the largest producer certifying 123 million kg, followed by the Italy (80.8 million kg) and Croatia (18.9 million kg).

- 293 million kg of maize seed were certified in 2019-20.
- France certified the greatest amount of maize seed (58 million kg) followed by Hungary (15 million kg) and then Italy (9.7 million kg) .

- 77 million kg of sunflower seed was certified in 2019-20, with France as the largest producer (23.8 million kg).

India's Strength

Wheat
Sunflower hybrids
Sorghum
Maize hybrids
Cotton hybrids
Rapeseed & mustard
Solanaceous vegetables

Framework for implementation of OECD Seed Scheme in India

National Designated Authority (NDA): The Joint Secretary (Seeds), DA&FW, GoI

Nine Designated Authorities (DAs)

Sl. No.	Name and Address of DA	Code	Area of jurisdiction
1	Andhra Pradesh State Seed Certification Agency, Guntur	AP	Andhra Pradesh And Odisha
2	Bihar State Seed Certification Agency, Patna	BH	Bihar, Jharkhand, West Bengal, Andaman & Nicobar, North-Eastern States and Sikkim
3	Maharashtra State Seed Certification Agency, Akola	MH	Maharashtra, Gujarat, Daman & Diu, Dadra & Nagar Haveli and Goa
4	Telangana State Seed and Organic Certification Authority, Hyderabad	TL	Telangana, Chhattisgarh
5	Rajasthan State Seed & Organic Production Certification Agency, Jaipur	RJ	Rajasthan, Haryana, Punjab, Chandigarh and Madhya Pradesh
6	Uttarakhand State Seed Certification Agency, Dehradun	UK	Uttarakhand, Delhi, Himachal Pradesh and Jammu & Kashmir
7	Uttar Pradesh State Seed Certification Agency, Lucknow	UP	Uttar Pradesh
8	Directorate of Seed and Organic Certification Agency, Coimbatore	TN	Tamil Nadu and Puducherry
9	Karnataka State Seed and Organic Certification Agency, Bengaluru	KA	Karnataka

Action Plan

- Identification of crops and their varieties which have **export potential**.
- **Adaptability of identified crop varieties** in particular countries where we are planning to export
- **Identification of Seeds Companies/Stake** holders through seed associations
- **Review of internal Seed Quality System** for attracting the demand of Indian Seed.
- **Create the demand** of Indian Seed in targeted foreign country.
- International market survey.

Telangana leading the OECD Seed Schemes

Telangana State Seed and Organic Certification Authority (TSSOCA)

Jurisdiction: Telangana and Chhattisgarh

Telangana is the first State in the country to export seed (17 MT) to OECD countries such as Egypt, Sudan, Philippines, Russia, Italy and Tanzania in 2016.



**Handbook on
OECD Varietal Certification in India**

OECD Seed Certification undertaken by TSSOCA during 2019-20

Crop	Area Registered (Ac)	Area Certified (Ac)	Quantity Produced (Qtls)	Quantity Exported (Qtls)
Sorghum	284.75	284.75	3415.17	180
Maize	1006.8	940.8	9871.46	400
Paddy	250	250	1909	Nil
Bajra	312.75	294.75	1492.48	200.16
Sunflower	182	182	613.4	170
Canola	Nil	Nil	230.07	Nil
Cotton	190.25	190.25	232.11	Nil
TOTAL	2226.55	2142.55	17292.9	950.16

**National Designated Authority
OECD Seed Scheme
Department of Agriculture and Cooperation
Ministry of Agriculture, Government of India
New Delhi**

September, 2014

Seed imports impacted due to COVID-19 restrictions

Status of ISTA Accreditation in India

S. No.	Laboratory	Type
1	INML 1400, Kalash Seeds Pvt. Ltd.	Private Sector
2	INML 0700, Indo-American Hybrid Seeds Pvt. Ltd.	Private Sector
3	INML 0600, Maharashtra Hybrid Seed Company Pvt. Ltd.	Private Sector
4	INML 0500, Namdhari Seeds Pvt. Ltd.	Private Sector
5	INML 1200, Nuziveedu Seeds Ltd.	Private Sector
6	INML 4500, East West Seeds India Pvt. Ltd.	Private Sector
7	INML 1600, STL, Depart. of Seed Certification, Tamil Nadu	Public Sector
8	INML 3900, Telangana State Seed & Organic Certification, Authority	Public Sector

20 Member laboratories

- 10 public sector laboratories
- 10 private sector laboratories

Seed Health Testing As a Phytosanitary Measure

- Seeds may present a pest risk. They are, therefore, routinely tested to prevent seed movement, and their introduction into new territories.
- Seed health test is also frequently a phytosanitary requirement imposed by national plant protection authorities before allowing seed to enter their territory.

The IPPC, EPPO and ISF regulated list are some of internationally accepted norms for plant quarantine.

Tests on seed lots must also be accepted internationally

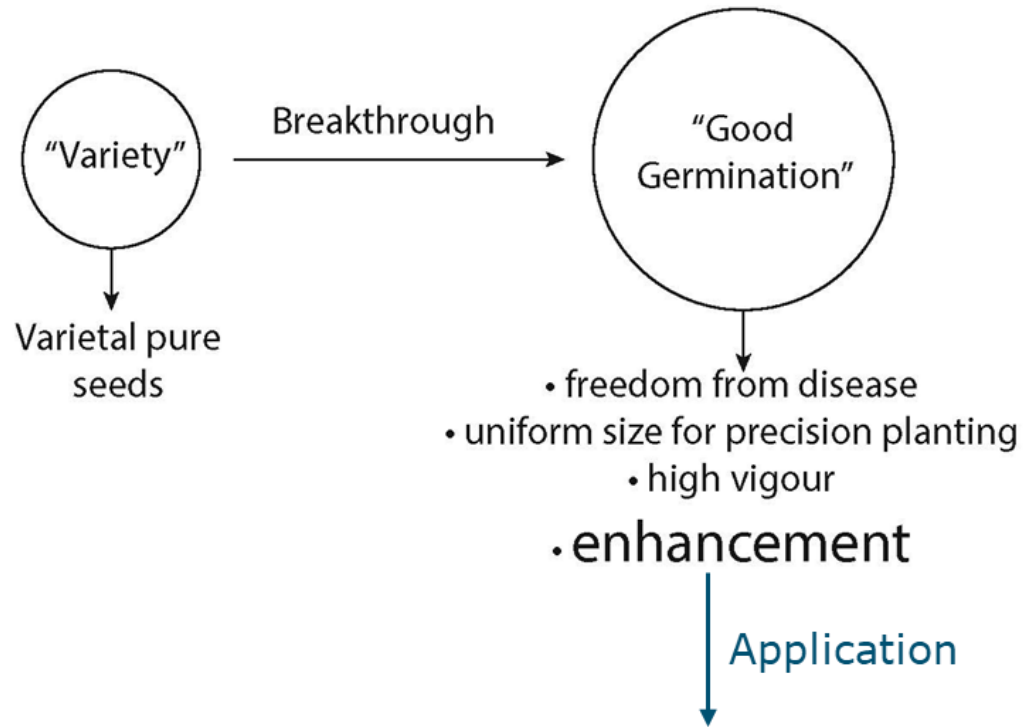


Indicative list of harmonized protocols for testing seed lots moving in international trade

Crop		Pest(s)	Method(s)
Common Name	Scientific Name		
Cucurbit species	Cucurbitaceae	Acidovorax citrulli	Seed extract qPCR
		Cucumber green mottle mosaic virus	ELISA
		Melon necrotic spot virus	
		Squash mosaic virus	
Pepper	Capsicum annuum	Tobamoviruses	ELISA, Bioassay
		Tomato brown rugose fruit virus	Seed extract qPCR, Bioassay
		Xanthomonas spp.	Dilution plating, Identification PCR
			Pathogenicity assay
Tomato	Solanum lycopersicum	Clavibacter michiganensis subsp. michiganensis	SE-qPCR, Dilution plating Identification PCR, Pathogenicity assay
		Pepino mosaic virus	ELISA, Bioassay, Confirmation ELISA
		Pospiviroids	Seed extract qPCR
		Tobamoviruses	ELISA, Bioassay
		Tomato brown rugose fruit virus	Seed extract qPCR, Bioassay
		Xanthomonas spp.	Dilution plating, Identification PCR Pathogenicity assay

Source: International seed health initiative (ISHI), ISF, <https://worldseed.org/our-work/seed-health/ishi-technical-resources/>

Seed enhancement: Overview



- Improve germination/seedling growth through manipulation of seed vigour or physiological status of seed
- Facilitate seed planting (Coating, encrusting, pelleting)
- Delivery of materials (other than pesticides) needed at sowing (nutrients, inoculants)
- Remove weak or dead seeds using non-traditional upgradation techniques (colour, density)
- Tagging of seeds with visible pigments or other materials/markers for traceability and identity preservation

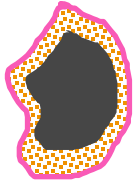
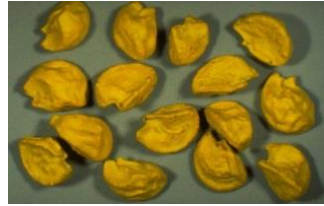
Product Forms Seed Coating



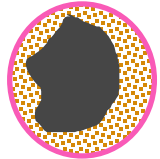
Basic coat,
Weight increase 0.2-2%



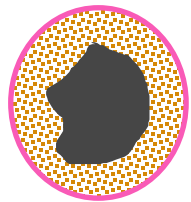
Complete Filmcoat,
Weight increase 3-20%



Encrustation,
Weight increase 1-5X



Mini pill,
Weight increase 10-25X



Standard pill,
Weight increase 15-100X



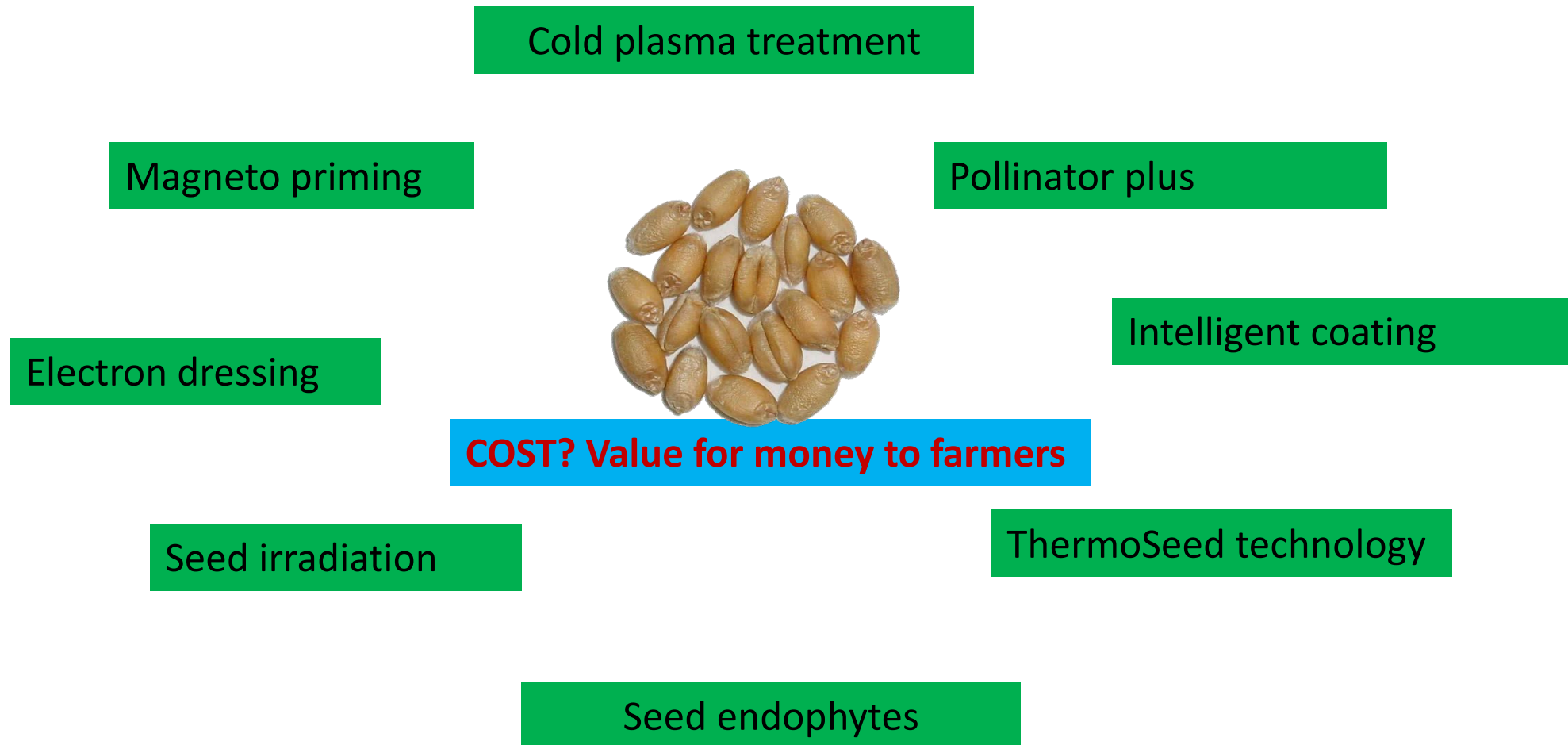
Challenges

Country to country regulations differs for seed treatment standards, fungicides, insecticides used etc.

Problems to be addressed

- Dust-off
- Abrasion resistance
- Clumping
- Flowability
- Plantability
- Value addition based on sowing conditions (cold stress, soil borne pathogens etc.)

Other potential techniques



Challenges: The lack of biomarkers associated with the best/suitable dose/s or time-point to stop the treatment is hampering the implementation of physical seed invigoration protocols at the industry level.

Strengths of Indian Seed System

Diverse agro-climatic regions

- India has 15 major agro-climatic zones and 127 agro-climatic regions and 20 agro-ecological zones based on soils classifications.
- Ample opportunity to grow a variety of crops (be it tropical, semi-temperate, or temperate type).
- With similar agro-climatic conditions and edaphic conditions, Indian Plant varieties have an excellent fit in South Asian, South East Asian and African countries

Skilled man-power

- For catering needs of R&D in plant breeding, Biotechnology, seed production and seed technologies
- Undertake custom seed production.

Investments in seed production and Research

- Huge network of public and private sector
- Government seed producing and R& D institutes include: 1) National Seeds Corporation 2) State Seed Corporations 3) ICAR institutes 4) State Agriculture Universities
- Huge germplasm base
- Policy support by Governments

Excellent opportunity for India for exporting seeds to both sub-tropical and tropical regions of the world.

Growth Drivers / Opportunities for Indian Seed Market

Rise in Adoption of Hybrid Seeds

- Exploitation of hybrid vigour

Speciality traits

- Bio-fortification
- Elimination of antinutritional factors
- Mechanical harvesting

Breeding for abiotic & biotic stress resistance

- Climate change and associated abiotic stress
- Biotic stresses
- Water & Nitrogen use efficiency

Employing modern plant breeding tools

- MAS
- Genetic Transformation
- CRISPR-CAS

Consumer preference / processing industry demand

- Wide geographical dispersion of production areas creates demand for various seeds specific to these conditions.
- **Processing industry**

Investment in hybrid seeds research and development is a key element and should be stepped up

POTENTIAL – INDIA: SEED HUB FOR ASIA AND AFRICA

1. FAVORABLE AND DIVERSE AGRO CLIMATIC ZONES
2. STRONG AGRICULTURE RESEARCH CAPACITY
3. SCIENTIFIC AND COMMERCIAL CAPABILITIES
4. STRONG SEED PRODUCTION CAPABILITY
5. CLIMATIC AND CROPPING PATTERN SIMILARITIES WITH COUNTRIES
6. LACK OF SEED INFRASTRUCTURE AND HUMAN RESOURCES IN THE AFRICAN AND ASIAN COUNTRIES
7. INDIA'S PARTICIPATION IN OECD SEED SCHEMES
8. PRESENCE OF MNC KNOWLEDGE SYSTEM

With proper **capacity building** in seed production processes, **Digitalization of supply chain** and **quality infrastructure development**, India can ramp up its exports to atleast **USD 500 mn in the next five years** and further to **USD 1Bn within 7-8 years**.

However this needs big **policy reform** push from Government for **strengthening the capacities** of domestic seed sector, **ease of doing business**, significant **investments in R&D**, coupled with **accreditation based seed quality systems** will enable harnessing the business opportunity particularly in similar agro-climatic regions in Asian and African continents.

