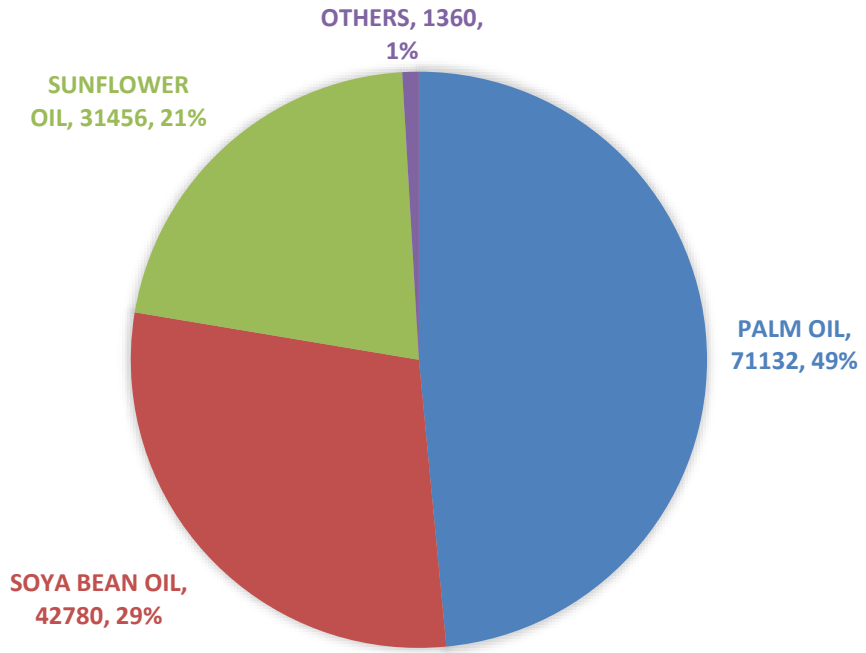
Enhancing Soybean Productivity in India

Dr Kunwar Harendra Singh
Director
ICAR- National Soybean Research Institute
Khandwa Road, Indore (M.P.)

Import of vegetable oil

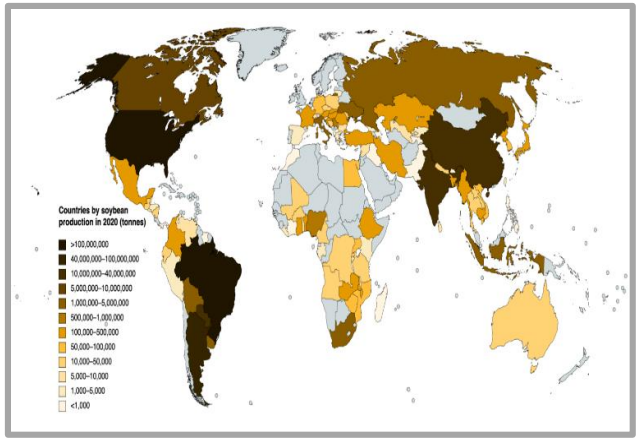
- India's Total Import of vegetable oils during 2024-25 was Rs 146728 crores
- Import of soybean oil was of Rs 42780 crores, approximately 29 percent of the total import value
- Value of soy seed meal export was Rs 7190 crores, hence 17 percent of total soy oil import was offset by the export of soymeal

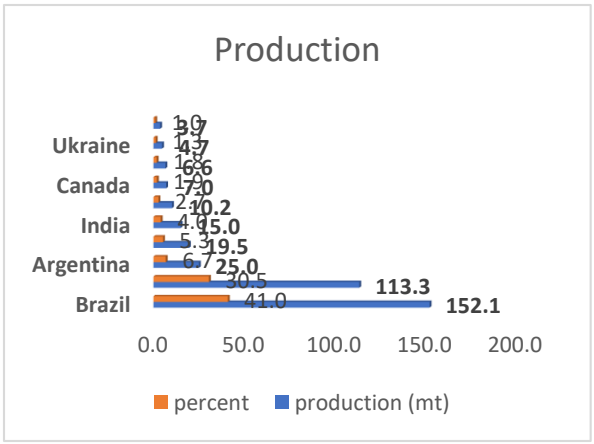


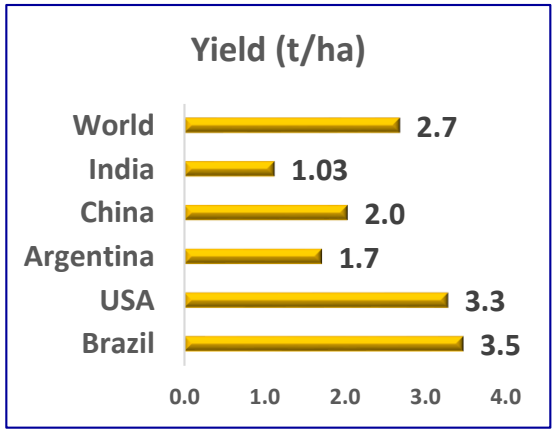
Soybean-Importance and Scenario

- Soybean is the most traded and processed crop commodity, predominantly used as soymeal, typically as a source of high protein (40%) for animal feed and as edible oil (20%).
- Ranks first among annual oilseeds crops in India in terms of oilseeds (15.1 million tonnes). Animal feed (DOC): Earns USD 1.2 billion as foreign Exchange, offsetting 38% of the soybean oil import bill.
- Its best benefits can be harnessed by value addition for human health and nutrition.

- 113 countries Produced 395 mt Soybean in 2024. Five Countries produced 89% of the world's total soybean. India ranked fifth in total production







Economic Importance of Soybean

- **Soybean national gross value = approximately ₹71,000 crore, or $8.5–8.7 billion USD**
- **Share of soybean in national GDP is 0.22 percent and to the national agricultural GDP is 1.2 percent**
- **After value addition the total contribution (direct + processing) ≈ $11–12 billion USD annually.**
- **At current prices, the Gross State Domestic Product (GSDP) of Madhya Pradesh was US$177.70 billion (approximately Rs. 15.22 trillion) during the 2024-25 fiscal year (FY25).**
- **Among the states, Madhya Pradesh ranks 10th in terms of Gross State Domestic Product (GSDP) and contributes about 4.5 percent to the national economy**
- **Agriculture contributes roughly one-third of the state's GSDP**
- **Soybean gross value in MP 2024-25 = US$3.02 billion (≈ ₹26,760 crore).**

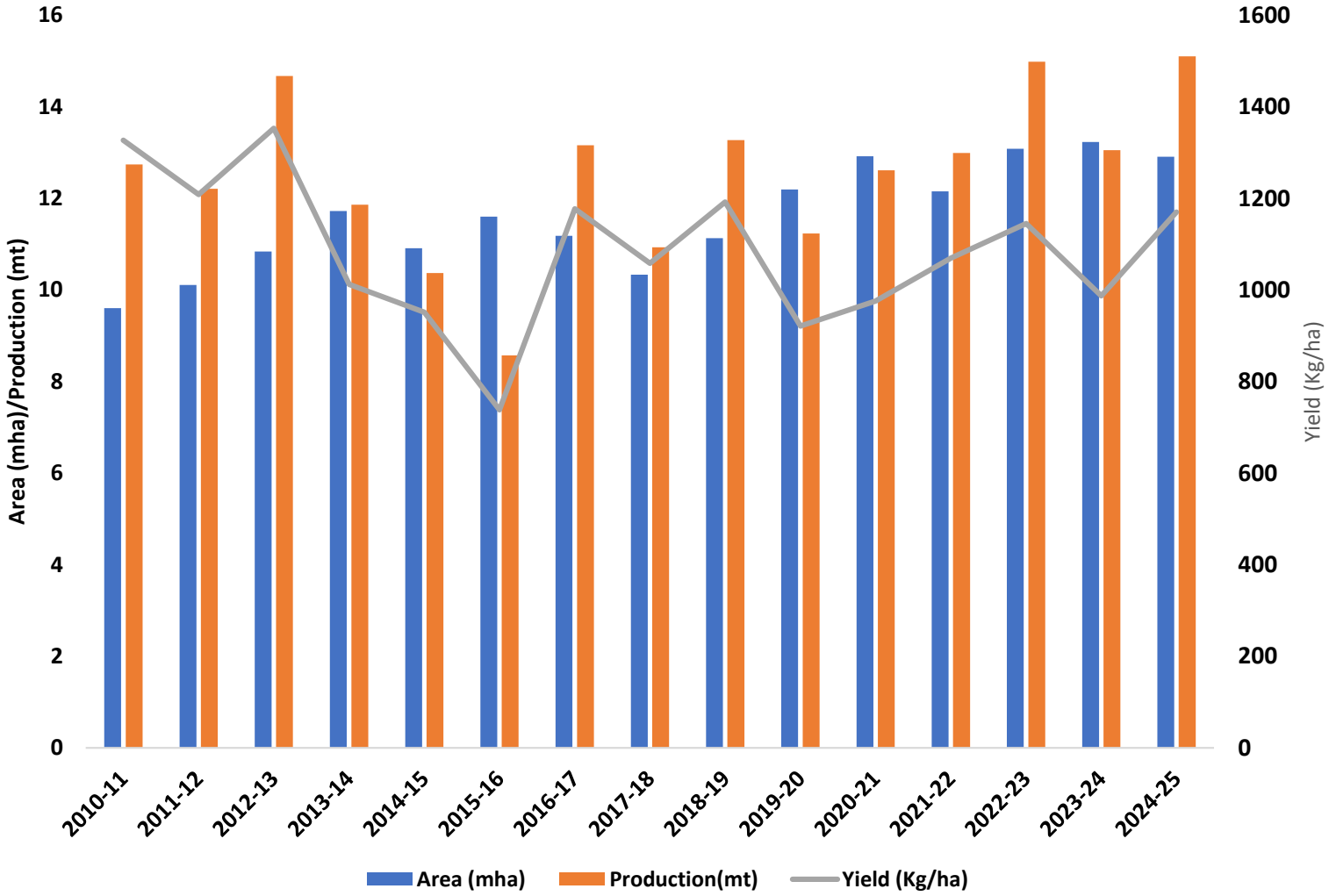
Area, Production and Yield of Major Crops Grown in Madhya Pradesh (2024-25)

Soybean ranks second after wheat in MP in respect to the acreage.

Mean yields, however, are only 9 q/ha, due to various reasons.

Crop	Area (mha)	Production (mt)	Yield (q/ha)
Wheat	7.757	23.366	30.12
Soybean	5.872	5.285	9.0
Paddy	3.833	8.831	23.04
Maize	2.077	5.789	27.87
Gram	1.692	2.458	14.53
Moong	1.262	1.425	11.29
Rapeseed Mustard	1.089	1.666	15.3
Groundnut	0.72	1.57	21.9
Cotton	0.54	1.54	4.86
Urad	0.519	0.362	6.97
Tur	0.179	0.174	9.7

Area, Production and Yield of soybean in India



Significant Achievements

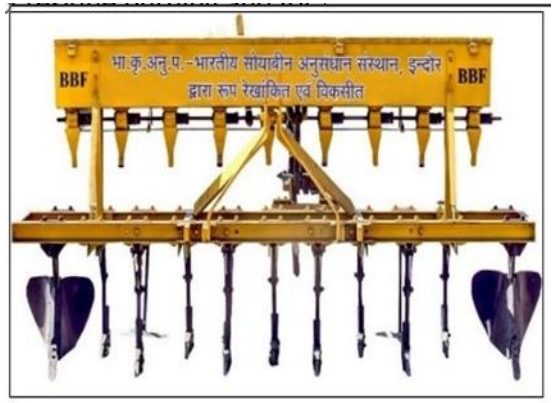
- Removal of pod shattering habit: Estimated benefit: 43501 crore (1985-2019)
- Rust-resistant varietal development. Estimated benefit 2187 crore (2014-2025)
- Early maturing varieties (90 days): 3 crops in a year.
- Development of 181 soybean varieties, 27 from ICAR-NSRI Indore.

Pod Shatter Resistant Varieties

Rust Resistant Varieties

Significant Achievements

- Development of agronomic practices, such as BBF, ridge and furrow planting.
- Standardized plant geometry 45 x 10 cm for medium/long maturing and of 30 x 5 cm for early maturing varieties
- Standardization of crop rotation of wheat-chickpea for a higher benefit-cost ratio.
- Standardization of intercropping with sugarcane, pigeonpea, and maize.
- Developed microbial endophytes, *Bacillus subtilis* & *Bacillus amyloliquefaciens* for disease management.
- Developed microbial consortia, *Bradyrhizobium spp (daqingense, liaoningense, japonicum), Burkholderia arboris*, *Bacillus aryabhattii*, in liquid form.
- Developed entrepreneurship, startups, and imparted training for value addition.



Broad Bed Furrow Machine

Conservation Agriculture with 3 crops Soybean – Potato - Wheat

Progress in Variety Development

Cycle 0 1970-80	Cycle 1 1980-89	Cycle 2 1990- 99	Cycle 3 2000-09	Cycle 4 2010-19	Cycle 5 2020-24
8	24	25	29	40	57
Clark 63 Lee Bragg Ankur Alankar Shilajeet	Type 49 Durga Gaurav Punjab 1 JS 2 MACS 13 MACS 58	JS 335 Hardee NRC 2 NRC 7 NRC 12 JS 80-21 PS 564 MACS 450	JS 95-60 JS 97-52 PS 1225 DSB1 PRS 1 VL Soya63 JS 93-05 NRC 37 LSB 1	JS 20-34 JS 20-69 JS 20-98 JS 20-116 NRC 86 NRC 127 MACS 58 MACS 1188 SL 744 Raj Soya 24 RKS 113	NRC 150 NRC 142 NRC 130 NRC 131 NRC152 NRC 157 JS 21-72 JS 20-69 JS 20-98 JS 20-116 RVSM 11-35 RSC 10-46 MAUS 725

Soybean Yield Improvement in India

Before 1970 Cycle 0

Yield (Kg/ha)= 426

Area/annum (mha) =0.03

Local Soybean

- Kalitur in MP
- Other local soybeans in foot hills of Himalaya

1970 to 1990 Cycle 1

Yield (Kg/ha)= 735

Area/annum (mha) =0.69

Soybean Introduction

- Bragg, Lee, Improved Pelican, Hardee
- 1.7 times higher yield over Kalitur by high pod number, seed weight, short duration and biomass

1990 to 2015 Cycle 2

Yield (Kg/ha)= 1061

Area/annum (mha) =7.1

Hybridization

- Hybridization of breeding lines and developed cultivars
- 1.4 times higher yield than cycle 1 cultivars by harvest index and seed filling duration

2015 onwards Cycle 3

Yield (Kg/ha)= 1043

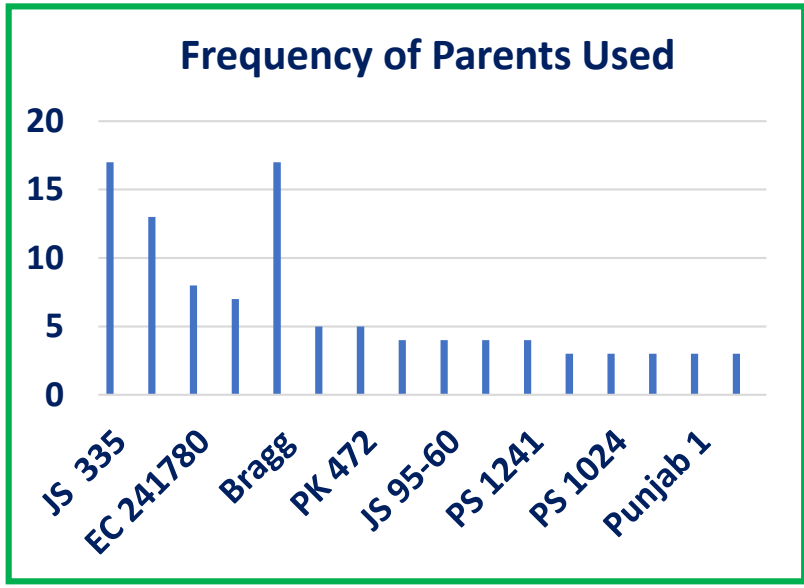
Area/annum (mha) =12.1

Integrated solutions

- Use of Marker assisted selection
- NRC 127 first variety developed through MAS in soybean

Narrow Genetic Base

- Initial introduced varieties form the base of Indian Soybean varieties
- 183 varieties
- 72.67% genetic contribution from 10 ancestors.
- 'Bragg' and JS 335 direct parent in 17, JS 97-52 in 13 and varieties



Challenges in soybean production

Abiotic stress

- Drought
- Waterlogging stresses

Biotic stress

- Disease, insect-pests and weeds

Physiological constraints

- Highly photosensitive crop
- Presence of anti-nutritional factors (KTI, LOX)

Machinery

- Limited machineries available from sowing to harvesting.

Challenges in soybean seed production

- Poor seed longevity, Low Seed Multiplication Ratio

Challenges in soybean production

Soil Health

- Low organic carbon (<0.5%)
- Poor Drainage in vertisols
- Poor Nutrient Profile (Iron Deficiency)
- Sub-soil compaction

Weeds

- Continuous rains prevent spray and manual weed removal

Diseases

- Inoculum buildup due to continuous soybean cultivation.
- Break down of disease resistance in soybean varieties
- No-availability of molecules for RAB.

Insects

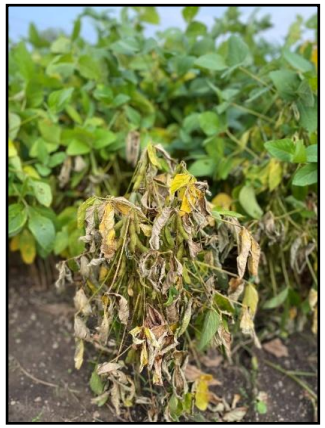
- Effective insecticide available but continuous rains prevent spray
- Spurious chemicals

Emergence of new diseases

Major diseases by zone include:

- **Central Zone:** Rhizoctonia aerial blight, Charcoal rot, Anthracnose
- **Southern Zone:** Rust, Anthracnose, Purple seed stain
- **Northern Plains:** Yellow mosaic disease
- **Eastern Zone:** Indian bud blight
- **Northern Hill Zone:** Frogeye leaf spot, Anthracnose
- **North-Eastern Hills:** Collar rot

Anthracnose



Rhizoctonia Aerial Blight

Charcoal rot

Yellow mosaic

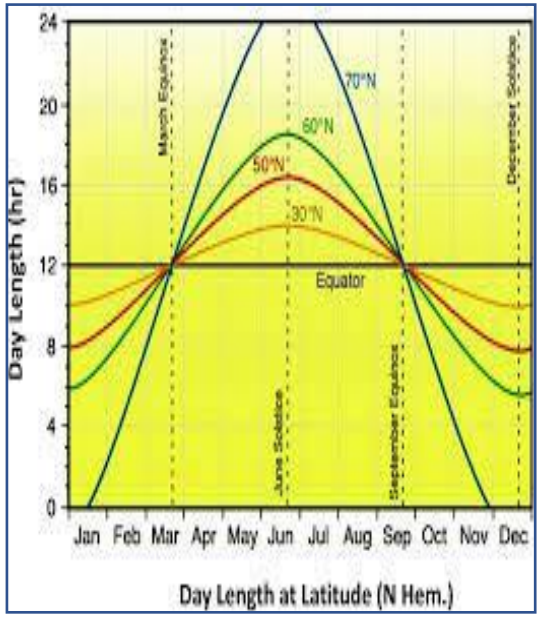
Rust

Collar rot

Physiological constraints

Photosensitivity

- Highly photoperiod sensitive short day crop
- Narrow adaptation of varieties to sowing duration, latitudes and seasons
- In India, Photo-sensitivity confers early maturity and adapts soybean to short growing rainfed season (90-95 days)
- Varieties from maturity group III to VII may fit to different agroclimatic conditions of India.



Average Yield of Latest (< 10 year old) Varieties under AICRPS

Zone	States	Recent Varieties	Grain Yield (Kg/ha)
NHZ	Himachal Pradesh, Hills of Uttarakhand	VLS 99	2359
NPZ	Punjab, Delhi, Plains of Uttarakhand	PS 1670	2371
		NRCSL 3	2400
NEZ	Chhatisgarh, Jharkhand, Orissa, Assam, Meghalaya, Manipur	RSC 10-52,	1858
		RSC 10-46	2248
		RSC 11-07	1916
CZ	Madhya Pradesh, Maharashtra, (Vidarbha & Marathwada), Rajasthan, Gujarat, Bundelkhand region of UP	**JS 21-72**,	2139
		Himso 1689	2077
		RSC 10-46	1947
SZ	Western Maharashtra, Karnataka, Adilabad,	**JS 20-98**	2093
		KDS 992	2653

ACTION PLAN

Research action plan

- Breeding for multiple disease resistance
- Marker-assisted introgression of YMV resistance in soybean mega-varietiesEmploying kairomones in pest management
- Deploying GM-technology in weed management
- Improving existing varieties for multiple disease tolerance
- Development of drought and waterlogging-tolerant varieties; use of straw mulch, life-saving irrigation

Policy action plan

1. Re-introduction of Bhavantar scheme
2. Development of Seed Hubs at Different Agro-Climatic Zone
3. Market Linkages between farmers and processors for avoiding middle men
4. Make Soybean Part of Government Nutrition Schemes
5. Marketplace Outlets for FPOs for SOY Food Products
6. Integration of sustainability frameworks
7. Soil health cards for each field
8. Application of biological agents (*Trichoderma*, *B. subtilis*, *Pseudomonas*)

Action Plan for Enhancing Soybean Yield

- **Soil health: government interventions in disseminating Trichoderma technology**
- **Good agronomic practices: Awareness and implementation of available production technologies through training**
- **Weed: government interventions in deploying GMO technologies**
- **Biotic stress: Integrated pest & disease management, multiple pest & disease tolerant varieties**
- **Seed: Availability of 1 Lakh Q certified seeds by production agencies (NSC, SSC) by 4th year of varietal notification.**
- **Policy intervention in value addition through soya-based MSMEs.**
- **Awareness of soya products through mass media.**
- **Entrepreneurs and machine manufacturers should focus on developing cost-effective, energy-efficient machinery for protein concentration, extrusion, and packaging.**

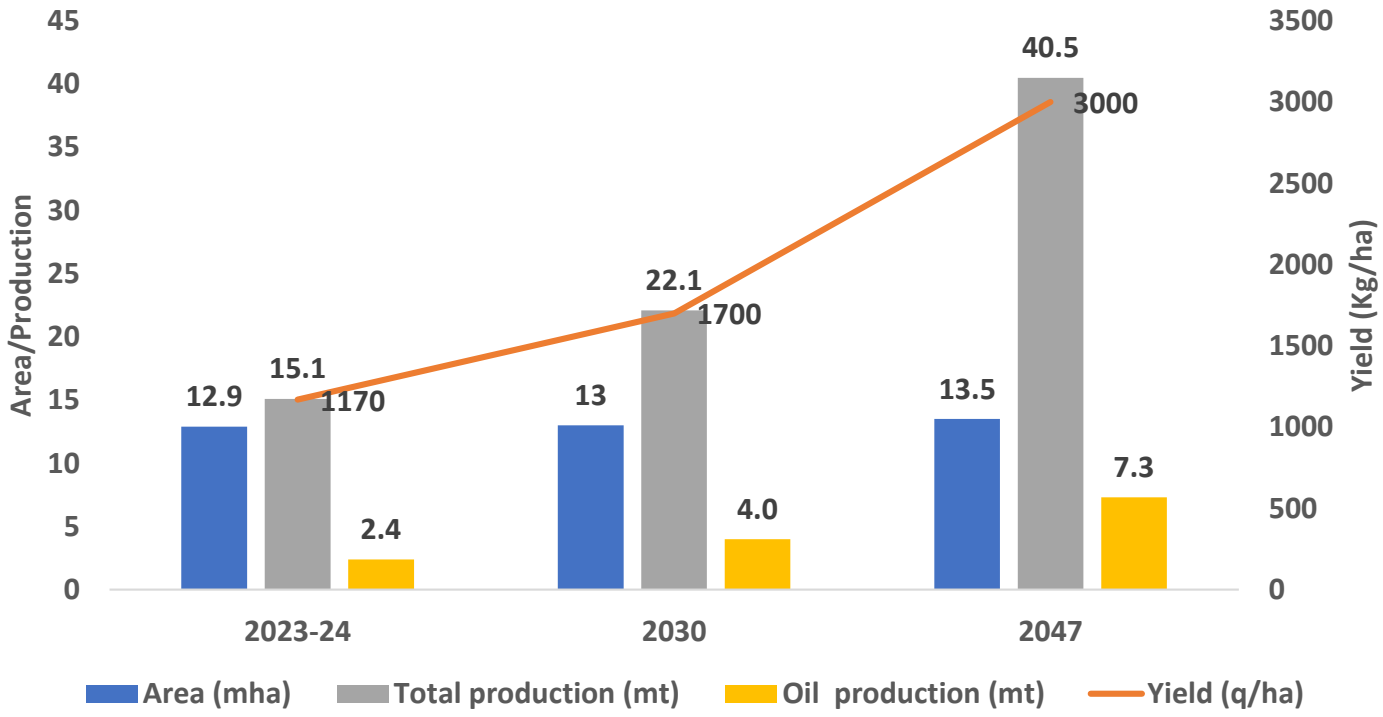
Action Plan for Rapid Seed Availability of New Varieties

- Variety Notification: 10 Q seed: Concerned Breeder (1st Year)
- Off season breeder seed (1st Year) Off season production: 100 Q Concerned Breeder
- Breeder Seed; 1000 Q : 2nd Year: Concerned Breeder + NISR
- Foundation Seed: (3rd Year); 10000 Q : NSC and SSC
- Certified Seed (4th Year); 1 lakh Q: NSC & SSC
- Farmer to farmer varietal dissemination through seed village: State Government

Role of Industries for Soybean Development

- Industry and ICAR NSRI linkage for research and development programs-CSR Fund
- Establishment of Industry and market support in non traditional areas
- Premium price policy for food grade soybean
- Trade marking for soy foods

Future Projections of Soybean




Thank You