


New Developments in Soybean Cultivation in India



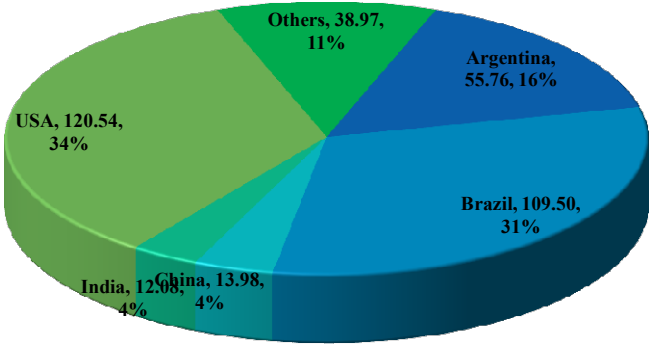
Dr. Sanjay Gupta
Principal Scientist and I/c Crop Improvement Division
ICAR- Indian Institute of Soybean Research, Indore

ICAR- Indian Institute of Soybean Research, Indore



1


Global Production of Soybean (av. 2016-17 to 2018-19)



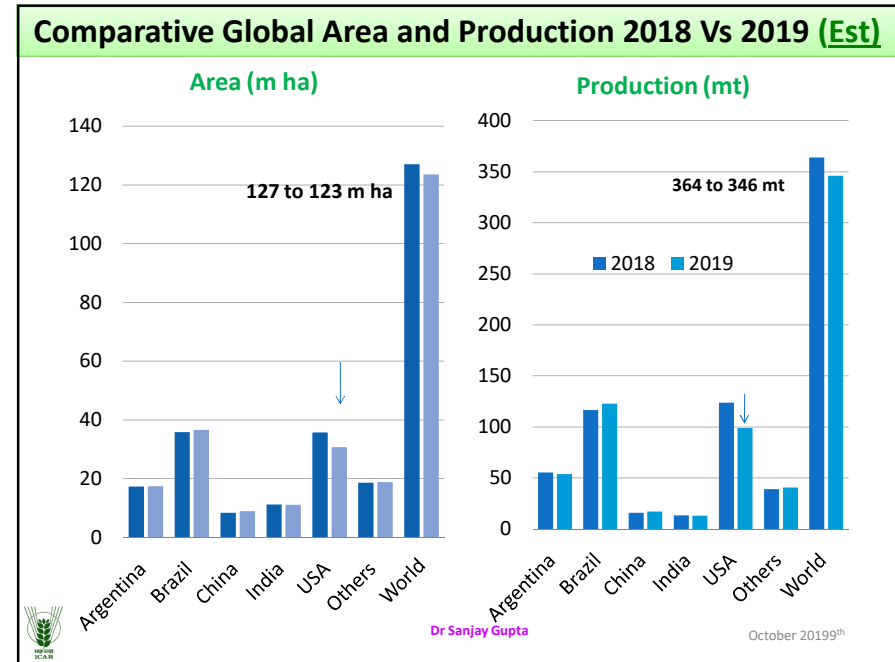
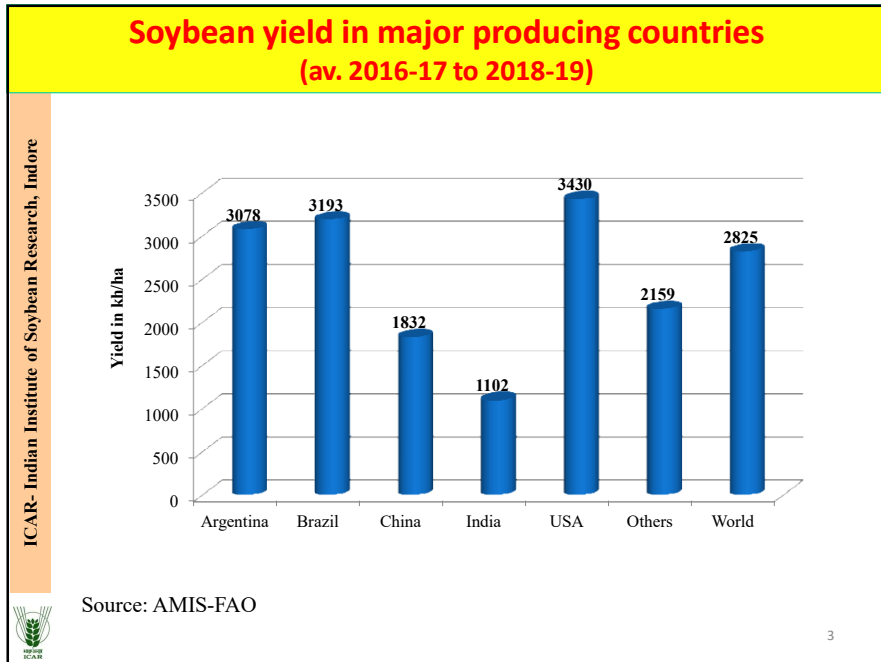
Country	Production (Million Metric Tons)	Percentage
USA	120.54	34%
Brazil	109.50	31%
Argentina	55.76	16%
China	13.98	4%
India	12.08	4%
Others	38.97	11%

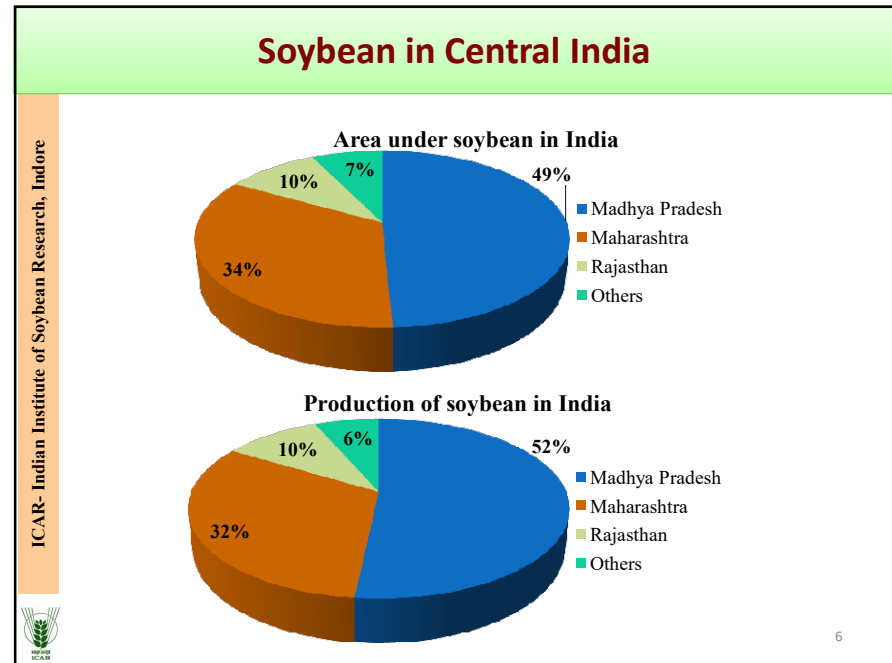
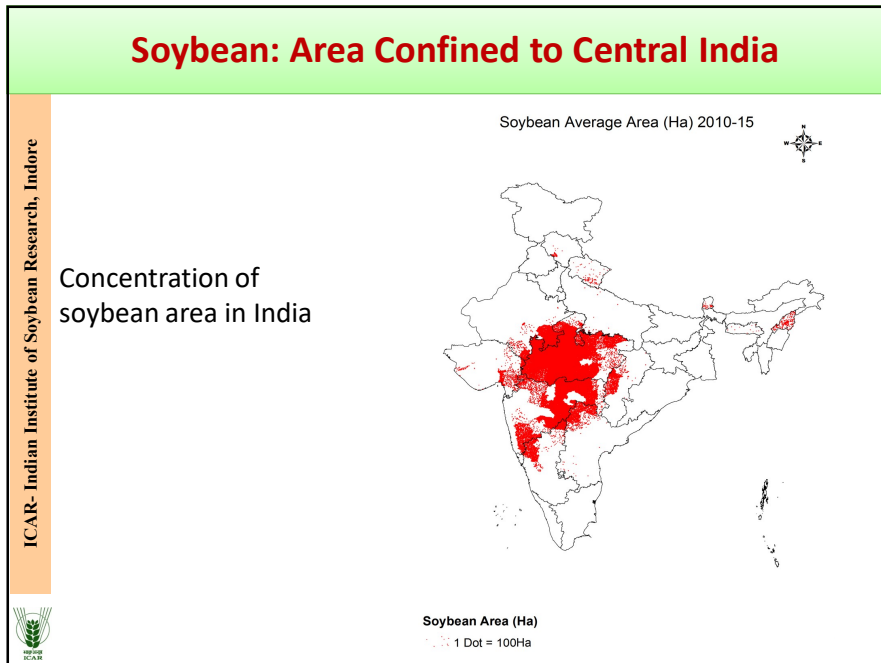
Source: AMIS-FAO

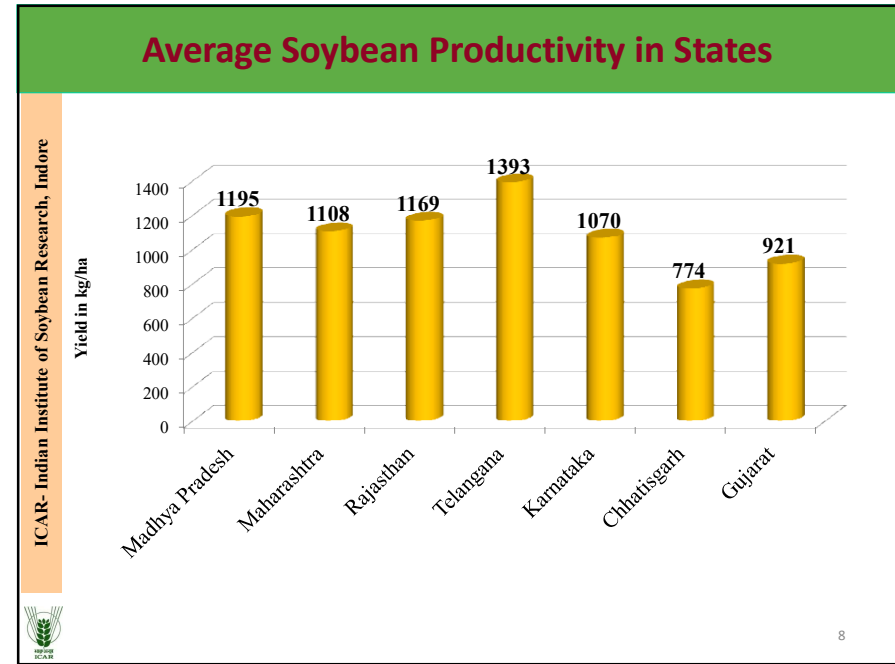
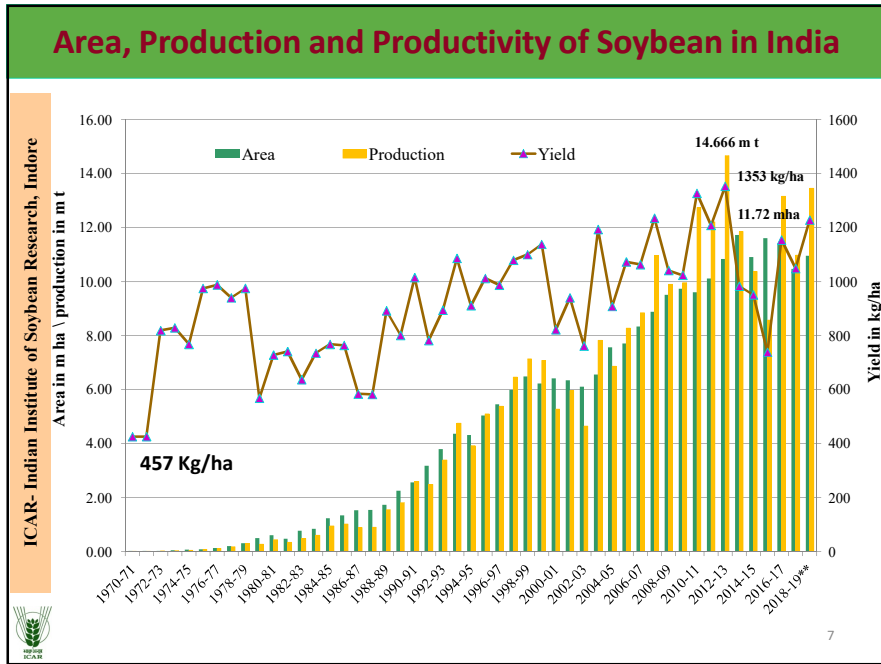
ICAR- Indian Institute of Soybean Research, Indore



2







Sowing position of Soybean in India as on 27.09.2019 (Area in Lakh Ha)

States	2019	Same period 2018	Same period 2017
Bihar	0.420	0.368	0.000
Chhattisgarh	0.742*	1.290	1.320
Gujarat	1.003*	1.365	1.290
Karnataka	3.302*	3.394	2.710
Madhya Pradesh	55.160**	53.180	50.100
Maharashtra	40.113*	40.444	38.397
Rajasthan	10.608**	10.461	9.690
Telangana	1.770*	1.789	1.650
Uttar Pradesh	0.208**	0.199	0.195
Uttarakhand	0.260**	0.240	0.250
Others	0.402**	0.367	0.319
Total	113.988**	113.097	105.921

ICAR- Indian Institute of Soybean Research, Indore



Dr Sanjay Gupta

October 2019th

Comparative Indian Area and Production 2018 Vs 2019 (Estimated)

Year	Area ('000 Ha)	Production ('000 Tons)	Yield (Kg/Ha)	Change in Area (%)	%Change Production	%Change in Yield
2016-17	11.1834	13158.7	1177			
2017-18	10.3288	10933.0	1058	-7.6	-16.9	-10.1
2018-19*	10.9600	13786.0	1258	6.1	26.1	15.2
2019-20**	11.3990 ^a	13505.0	1185	4.0	-2.0	-2.8

*Fourth advance estimates, ** First advance estimates,

^a All India weather summary and forecast bulletin 27.09.2019(<http://agricoop.nic.in/sites/default/files/Cwwg-Data-as-on-27.09.2019.pdf>).

Source: Directorate of Economics and Statistics, MOA&FW, New Delhi.

ICAR- Indian Institute of Soybean Research, Indore



Dr Sanjay Gupta

October 2019th

Yield Potential and Yield Gap in Soybean

ICAR- Indian Institute of Soybean Research, Indore

Yield potential (as per Simulation study):

- Average water non-limiting potential: 3.0 t/ha
- Average water limiting potential: 2.2 t/ha

Yield Gap:

- FLD average yield with full package: 1.8 t/ha
- National average: 1.1 t/ha
- Average yield gap: 0.7 t/ha



11

Low Yield of Soybean : Issues

ICAR- Indian Institute of Soybean Research, Indore

- The majority of the crop is rainfed (95%)- **weather variability**
- Only two early maturing varieties (< 90 days) in Central India.
- Lack of abiotic stress (drought, heat, waterlogging) tolerant varieties of suitable maturity duration.
- Limited varieties with biotic stress (YMV, charcoal rot and anthracnose) resistance with desirable maturity group.
- Low adoption of improved crop production technology
 - Seed treatment- low adoption
 - Continuous mono-varietal culture
 - Increasing insect-pest infestation
 - Poor soil fertility and imbalanced nutrient application
- Poor availability of quality inputs at affordable prices
- Farm Implements



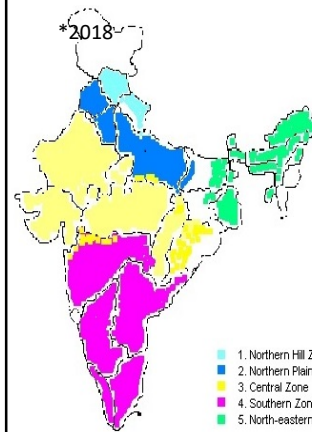
12

New Varieties for Different Zones



13

Six Agroclimatic Zones







1. Northern Hill Zone
2. Northern Plain Zone
3. Eastern Zone
4. North Eastern Hill Zone
5. Central Zone
6. Southern Zone

- 120 soybean varieties released
- 47 under seed chain




Northern Hill Zone (NHZ)

States	Uttarakhand and Himachal Pradesh; J & K included in 2018	
Main Diseases	Frog Eye Leaf Spot (Hot spots).	
Abiotic Stress	Heavy rains in few years	<div style="background-color: yellow; padding: 5px; text-align: center;">Frog Eye Leaf Spot</div>  
Desirable features in varieties	Earliness	
Additional Requirement	Black seeded, null-KTI, null-lox	



15

Recent Soybean Varieties of NHZ

Variety	VLS 89	PS 1556	VL Bhat 202 (Dal) (UK)	Shalimar Soybean (J& K)
Notified / Identified	Notified 2019	Under notification 2019	2018 (State Release)	2017 (under notification)
Days to Maturity	116	120	112	142
100 Seed Weight	14.4	12.5	16.4	18.5
Grain Yield (Q/ha)	23-25	23-25	15-17	22-25
Oil%	19.1	18.8	39.1% Protein 16.5%) Oil	-
Seed Colour	Yellow	Yellow	Black	Yellow
Resistance	MR to FLS	MR to FLS, R to YMV and SMV	MR to FLS, Pod Blight and Bacterial Pustules	-




Northern Plain Zone (NPZ)	
States	Punjab, Haryana, Delhi, UP (except Bundelkhand), Bihar
Main Diseases	Yellow Mosaic Virus, Soybean Mosaic Virus, Rhizoctonia Aerial Blight
Abiotic Stress	Photosensitivity
Desirable features in varieties	Earliness
Additional Requirements	Food Usages (null-KTI, null-lox)




Recent Soybean Varieties of NPZ			
Variety	SL 958	SL 979	SL 955
Notified / Identified	Notified 2016	Under notification (2019)	
Days to Maturity	122-124	125-128	124-128
100 Seed Weight	12.3	11.3	8.77
Grain Yield (Q/ha)	22-25	22-24	21-23
Oil%	19.7	20.6	18.9
Seed Colour	Yellow	Yellow	Yellow
Resistance	Resistant to YMV, MR to RAB and SMV		

Eastern (EZ) and North Eastern Hill Zone (NEHZ)


States	<ul style="list-style-type: none"> EZ: Chhatisgarh, West Bengal, Orissa, NEHZ: Assam, Meghalaya, Tripura, Nagaland, Manipur, Mizoram, Sikkim, Arunachal Pradesh
Main Diseases	<ul style="list-style-type: none"> Bud Blight in EZ, Rust and collar rots in parts of NEHZ
Abiotic Stress	<ul style="list-style-type: none"> Drought in EZ and Excess moisture in NEHZ




Rust



Collar Rot




Bud Blight



19

Recent Soybean Varieties of EZ and NEHZ


Variety	RSC 10-46 (EZ)	KDS 753 (EZ & NEHZ, SZ)	MACS 1460 (EZ & NEHZ, SZ)	JS 97-52 (EZ & NEHZ, CZ)
Notified / Identified	Identified 2016	Identified 2016	Identified 2016	Notified 2008
Days to Maturity	100-104	95-97 days (EZ)	92-98 (EZ) 100-103 (NEHZ)	102-105
100 Seed Weight	10	8.4	10.1	7.8
Grain Yield (Q/ha)	20-22	18-20 (EZ) 13-14 (NEHZ)	21-23 (EZ) 15-17 (NEHZ)	18-20
Oil%	16.2	16.1	17.6	-
Resistance	HR to Bud Blight	HR to Bud Blight	HR to Bud Blight	YMV, BB
Abiotic Stress	-	-	-	Tolerance to drought, heat and excess moisture




Central Zone	
States	Madhya Pradesh, Maharashtra (except western Maharashtra), Rajasthan, Gujarat
Main Diseases	<ul style="list-style-type: none"> Charcoal Rot Anthraxnose stem and pod blight YMV
Abiotic Stress	Drought, Excess moisture
Desirable Features in Vr	Early to Very Early (< 90 days)



Charcoal Rot




Anthraxnose




21

Drought and Heat




Not irrigated




Irrigated

JS 97-52




Not irrigated




Irrigated

JS 90-41

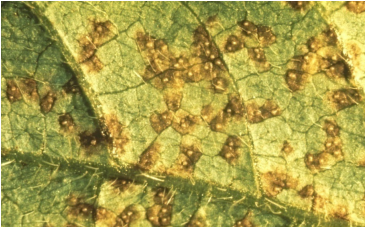
ICAR- Indian Institute of Soybean Research, Indore




Recent Soybean Varieties of Central Zone					
Variety	JS 97-52	JS 20-34	JS 20-69	JS 20-98	JS 20-116
Notified / Identified	Notified 2008	Notified 2014	Notified 2014	Notified 2019	Notified 2109
Days to Maturity	102-105	85-88		98-103	
Grain Yield (Q/ha)	23-25	18-20	23-25	20-22	22-24
Oil%	-	20.3	20-22	19.3	18.5
Resistance	<ul style="list-style-type: none"> HR to CR, MR to YMV Tolerance to drought and heat, Waterlogging 	HR to CR, MR to YMV			




Southern Zone	
States	<ul style="list-style-type: none"> Karnataka, Andhra Pradesh, Telengana, Kerala, Tamil Nadu and Western Maharashtra
Main Diseases	<ul style="list-style-type: none"> Rust in areas surrounding Krishna river
Abiotic Stress	<ul style="list-style-type: none"> Drought


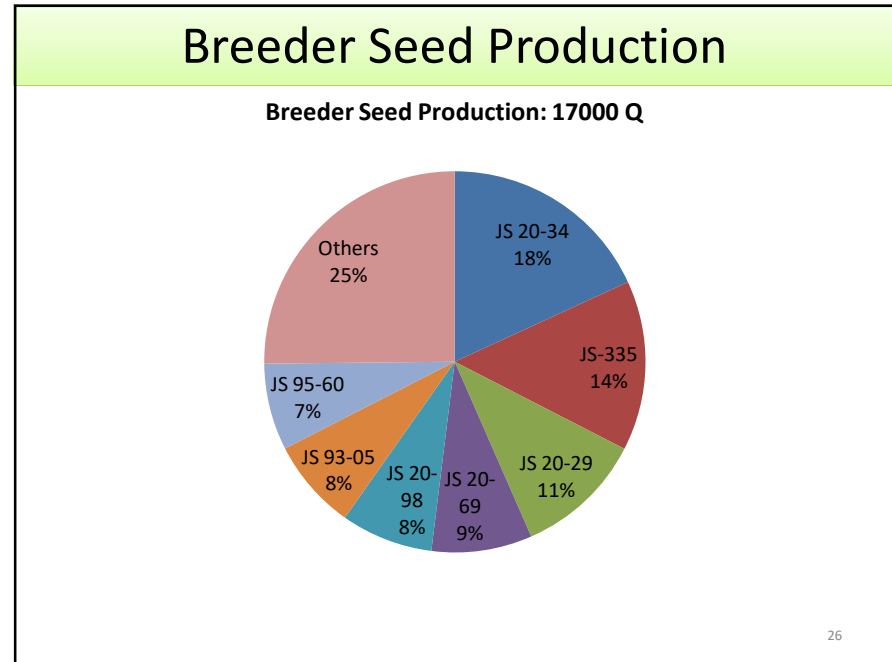


Soybean Rust





Recent Soybean Varieties of Southern Zone					
Variety	MACS 1460	KDS 726	DSb 21	DSb 23	DSb 28
Notified / Identified	Under Notification	Notified 2017	Notified 2015	Notified 2017	Under Notification
Days to Maturity	86-88	88-89	92-95	93-95	93-95
Grain Yield (Q/ha)	18-20	23-25	25-30	20-22	21-23
Oil%	18.9	18.4	18.2	18.6	20.1
Resistance	MR to Rust		HR to Rust		

Soybean for Food Usage

- 40% Protein and 20% Oil.
- Three limiting factors for soybean food usage
 - Presence of Trypsin Inhibitor
 - Presence of beany flavour in soy milk
 - Poor shelf life of soybean oil



Varieties with **null-Kunitz Trypsin Inhibitor (KTI)**

- KTI Binds with trypsin in intestine and results in poor protein digestion.
- Long term use may cause liver damage.
- Wet boiling inactivates it. Requires additional inputs.
- **KTI-free lines NRC 101 and NRC 102 developed commercialized. (Ruchi and ITC)**
- **Varietal conversion: JS 97-52 (NRC 127), NRC 7, MACS 450, JS 93-05**
- **NRC 127, the first null-KTI variety released in 2018.**



Varieties with Reduced Beany Flavor

- During processing Lipoxygenase Enzyme (Lox) reacts with PUFA and produce grassy and beany flavor.
- Wet heat inactivation: Cost and Protein insolubility.
- NRC 109 (Lox 2 free) commercialized: Sonic Biochem, Nature Bio foods limited.
- Varietal conversion: JS 97-52 (NRC 127), NRC 7, MACS 450, JS 93-05
- **Null lox varieties would be released in 2020.**
- **Varieties combining null KTI and reduced beany flavour would be released in 2021**

ICAR- Indian Institute of Soybean Research, Indore



Varieties with High Oil Shelf Life

- Oxidation of poly unsaturated fatty acids (PUFA)

	Mono-unsaturated	PUFA	
Fatty Acid	Oleic Acid	Linoleic Acid	Linolenic Acid
Amount	22%	55%	7%
Oxidation Rate	1	10	21



- Requirement for high oleic soybean
- Varieties with 80% oleic acid developed in world
- **Mid Oleic variety developed in IISR would be released in 2020.**
- Breeding lines up to 60% oleic acid developed in IISR Indore
- **High Oleic variety would be developed 2022.**

ICAR- Indian Institute of Soybean Research, Indore




Vegetable Soybean

Immature Seed shelled from the pods picked at R6





stage of reproductive phase when 80-90% of the pod cavity is filled and the seeds and pods still green




↓

Nutritious (vitamins, minerals)
like green pea, chick pea, french bean



ICAR- Indian Institute of Soybean Research, Indore




Vegetable Soybean Characters

ICAR- Indian Institute of Soybean Research, Indore

- Sweet in taste (about 8% sucrose at R6 stage)
- Large seed size (about 50g) at picking
- Mild beany flavour
- No flatulence factors (raffinose & stachyose)
- Quick-to-cook
- Protein 10 % ; Fat 3% on fresh weight basis

ICAR- Indian Institute of Soybean Research, Indore



NRC 105 and Karune: Vegetable Soybean

ICAR- Indian Institute of Soybean Research, Indore

- Trials initiated in AICRP in 2018
- NRC 105 and Karune promising entries
- Days to R6: 65-70 days
- 100 green seed weight: 60 (NRC 105) & 75 (Karune)
- Sucrose: 6.5 (Karune) and 8.0 (NRC 105)
- Green Pod Yield: 8-10 t/ha
- Green seed yield: 4-5 t/ha



Dr Sanjay Gupta

October 2019th

Enhancing soybean yield- Sowing and Seed rate

ICAR- Indian Institute of Soybean Research, Indore

- Suitable production technologies developed and continuously fine tuned:
- Optimum plating time (15th June to 5th July); Increase seed rate in delayed sowing.
- Optimum seed rate (60-65; 65-70; 70-75 kg/ha)
- Optimum soil moisture (at least 100 to 120 mm rains)
- Optimum sowing depth (2-3 cm)



34

Seed Quality Management

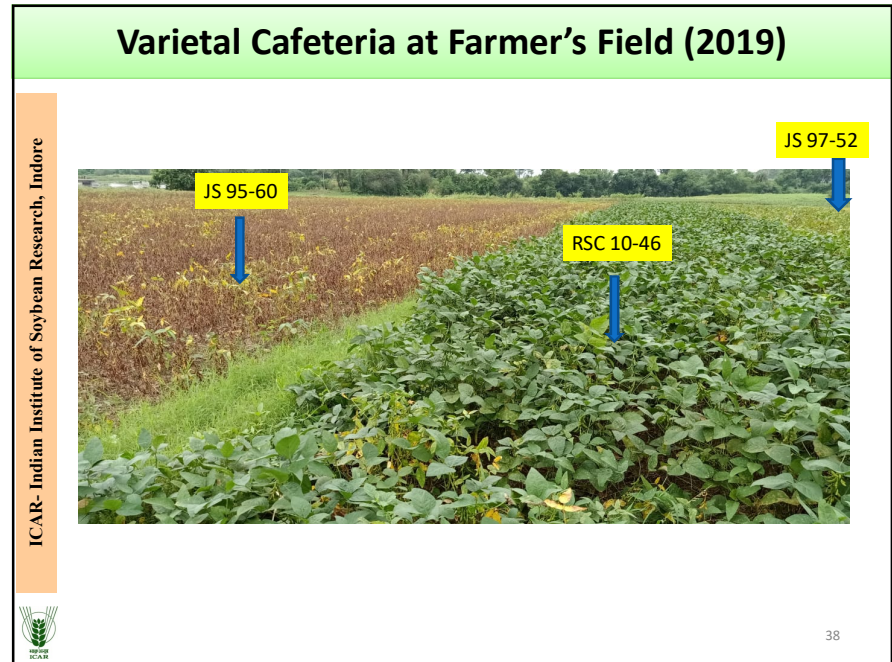
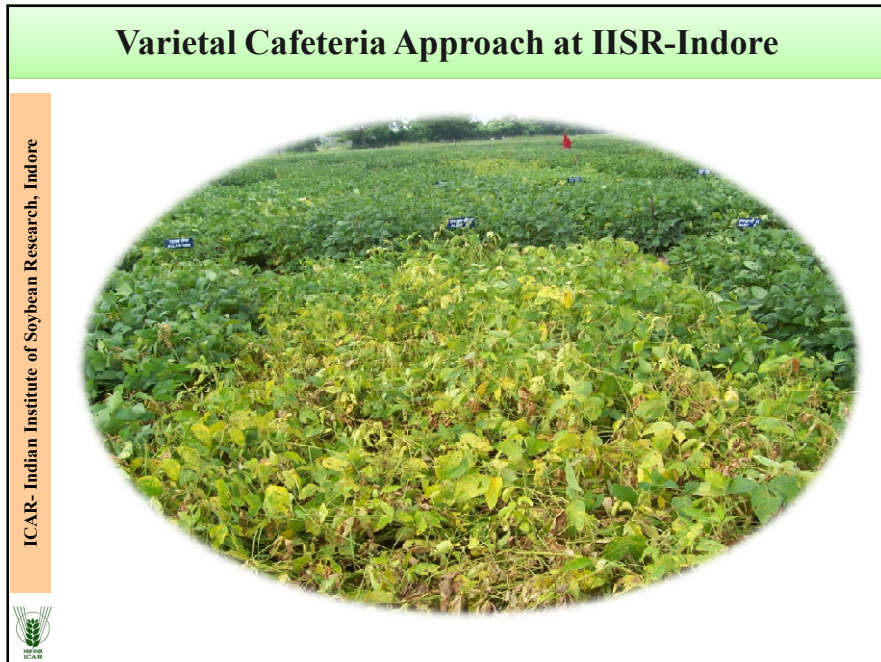
- **Seed polymer coating for better emergence, growth and protection**
 - Micronutrients (Mo, B),
 - biocontrol agents (Trichoderma),
 - fungicides (carboxin, thiram)
 - insecticides (Thiomethoxam)
- **Foliar salicylic acid application**
 - Increased seed yield , resistance to foliar diseases and better shelf life.
- **High seed coat lignin lines identified**
 - Lee, MACS 450, MAUS 47, VL Soya 1, PS 1042, JS 97-52

Growth of endophytic Trichoderma After seed polymer coating

Soybean for Mechanical Harvesting

- X-radiography
- gap between seed coat and cotyledons, and the position of radicle over the cotyledons varies among varieties
- Compact seed coat over the cotyledons reduces the risk of cracking
- Position of radicle is raised more over the cotyledons, the chances of damage to radicle is more

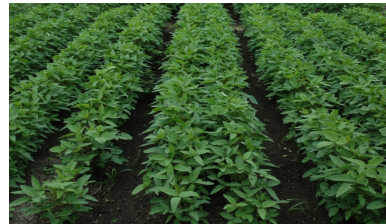
1/24/2017 Sanjay G Research, Indore



Enhancing Soybean Yield- Water Management

ICAR- Indian Institute of Soybean Research, Indore

- Planting on Broad-bed furrows (BBF) and Ridge-Furrow system 20% yield enhancement
- BBF seed drill (i) creates broad beds and (2) plant the soybean developed
- Provides effective drainage under high rainfall



Soybean planted on ridge-furrow system



Sowing of soybean with BBF Seed Drill



Soybean planted on BBF system

39



Micro irrigation: Technology for Future in Soybean

ICAR- Indian Institute of Soybean Research, Indore

- 16 m ha under micro-irrigation in USA. Mainly Sprinkler and Drip.
 - 17% of micro-irrigation area by Sub-surface.
 - Shift towards sub-surface. 0.2 m, 0.4 m, 0.6 m depth.
 - Last Up to 20 years.
- Researchable issues:
 - Row distance
 - Weed management: drip lines etc



40

Enhancing Soybean Yield- System Approach

ICAR- Indian Institute of Soybean Research, Indore

Soybean fits well in all traditional cropping system

Irrigated conditions:

- (i) Soybean- wheat
- (ii) Soybean-potato/Garlic/Onion-wheat


Unirrigated/Limited irrigation:

- (i) Soybean-Chickpea


Soybean based intercropping:

Soybean + Pigeonpea, Soybean + sorghum (unirrigated),
Soybean + Maize/Cotton/ Sugarcane etc. (Irrigated)

Intercrop seed drill for planting of soybean with intercrops has been developed, demonstrated and validated




Soybean+ Maize Intercropping



Intercrop Seed Drill

41



Crop Residue Management: Technology Under Development

- **Mulching with crop residues contribute to the conservation of soil and rainwater**
- **This method reduces evaporative losses, runoff from cropped fields**
- **Crop residues modify soil biological activity resulting in improved soil fertility and better soil physical conditions.**



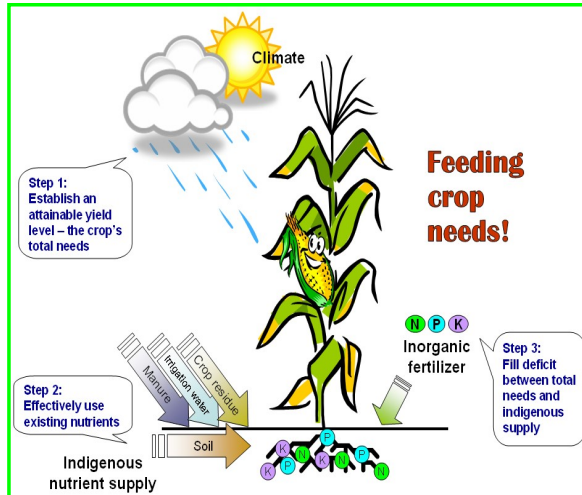




Site Specific Nutrient Management: Technology under Development

- We are developing Decision Support System for working out site specific nutrient requirement for soybean in collaboration with IPNI

✓ Addressing nutrient deficiencies which exist within field and making adjustment in nutrient application to match these locations or soil differences



Enhancing soybean yield- pest and disease management

ICAR- Indian Institute of Soybean Research, Indore

- Insects like **Stem fly**, **Girdle beetle**, **tobacco caterpillar (*Spodoptera litura*)** and **Bihar hairy caterpillar** are causing substantial yield losses.
- **Diseases like** Yellow mosaic, Charcoal rot, Anthracnose, Pod Blight, Collar rot, Rust etc. too are affecting the productivity potential of the soybean crop
- For them regular scouting is required so that immediate action can be taken
- Integrated insects and disease management which include use of variety, bio-control and chemicals has been recommended



Enhancing the soybean production- mechanisation

ICAR- Indian Institute of Soybean Research, Indore

- Soybean is a short season crop
- It provides a limited window for most of the agronomic practices that include planting time, management of weeds, control of insects and pests and harvesting
- The mechanization of agricultural operations can help in timely interventions and operations for harnessing potential productivity of the crop

- Subsoiler
- Seed cum fertilizer drills
- BBF/FIRBS seed drill
- Sweep seed drill
- Ridge fertilizer drill cum seed planter
- Intercrop seed drill



45

ICAR- Indian Institute of Soybean Research, Indore

Thank you very much



46