

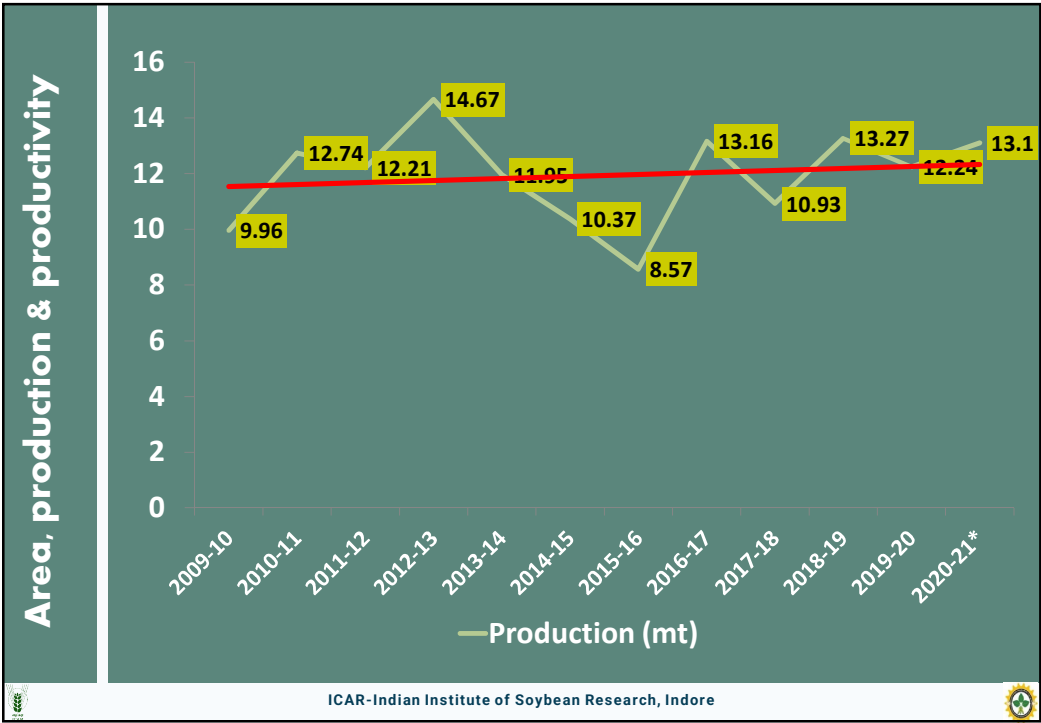
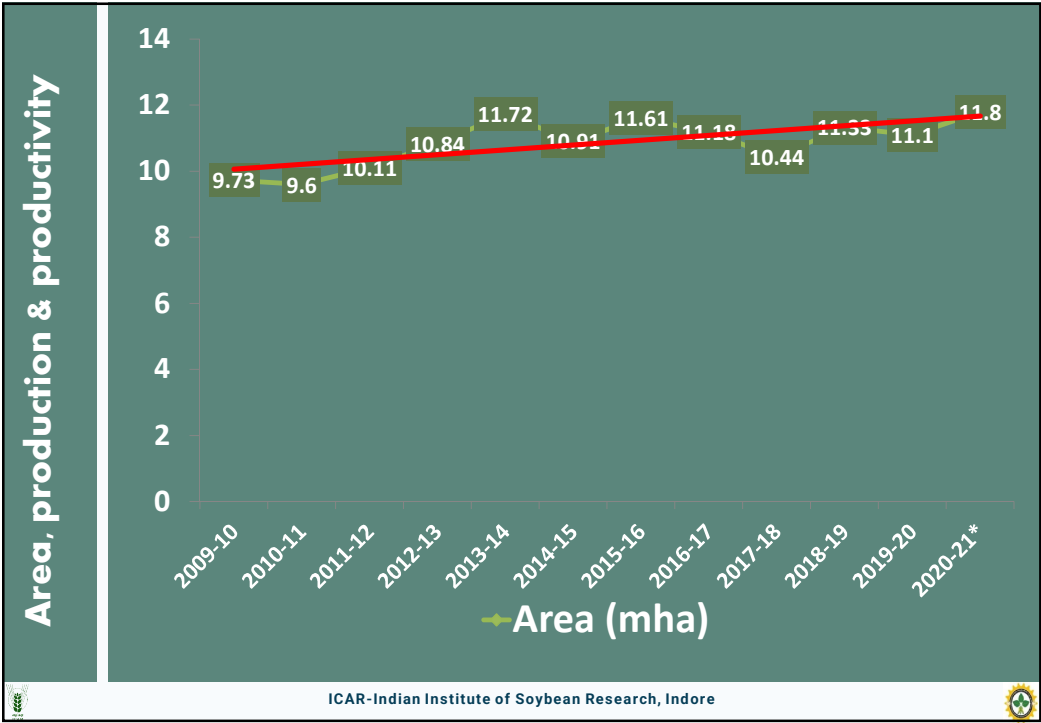


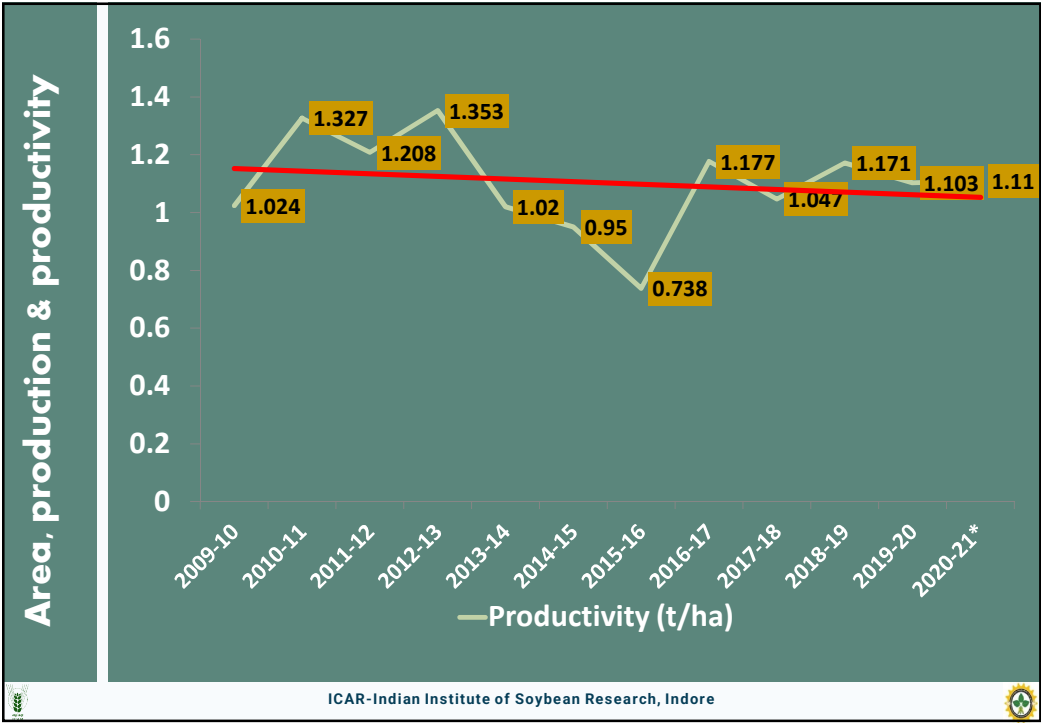
Soymeal value enhancement through genetic approaches and new food Uses



INTRODUCTION

- *Demand of soybean is increasing – increased use in animal feed*
- *92-93%(M.P, Maha. & Rajasthan]*
- *Expanding - Gujarat, Telangana, Karnataka, UP, Bihar etc*
- *Indian export – imports a sea-saw*
- *High quality protein and amino acid profile required by feed and food industry*
- *Antinutrient - Trypsin inhibitors, lectins, lipoxygenases, phytic acid, oligosaccharides (stachyose and raffinose), saponins are challenges*





Challenges

Low Yield

Narrow Gene Pool

Biotic stress

Breeding

Problems related to seed

Abiotic stress

Area Expansion

Yield Potential and Yield Gap in Soybean

Yield potential (as per Simulation study)

- Average water non-limiting : 3.0 t/ha
- Average water limiting : 2.2 t/ha
- Progressive farmers : 2.5 t/ha
- FLD average yield : 1.8 t/ha

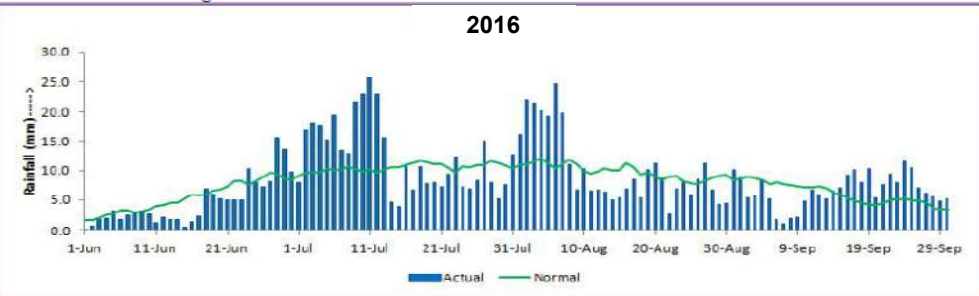
Yield Gap

National average: 1.1 t/ha
Average yield gap: 0.7 t/ha

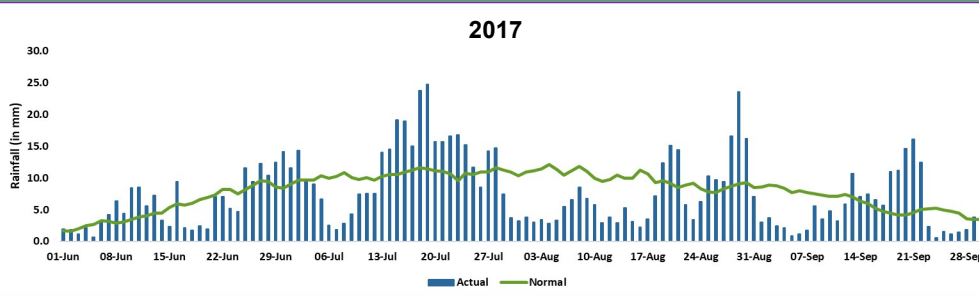
Short duration of the crop 90-95 days
Small holding 1.5 ha
At least two crops/year
Per day productivity/system productivity

Rainfall Trend in Central India

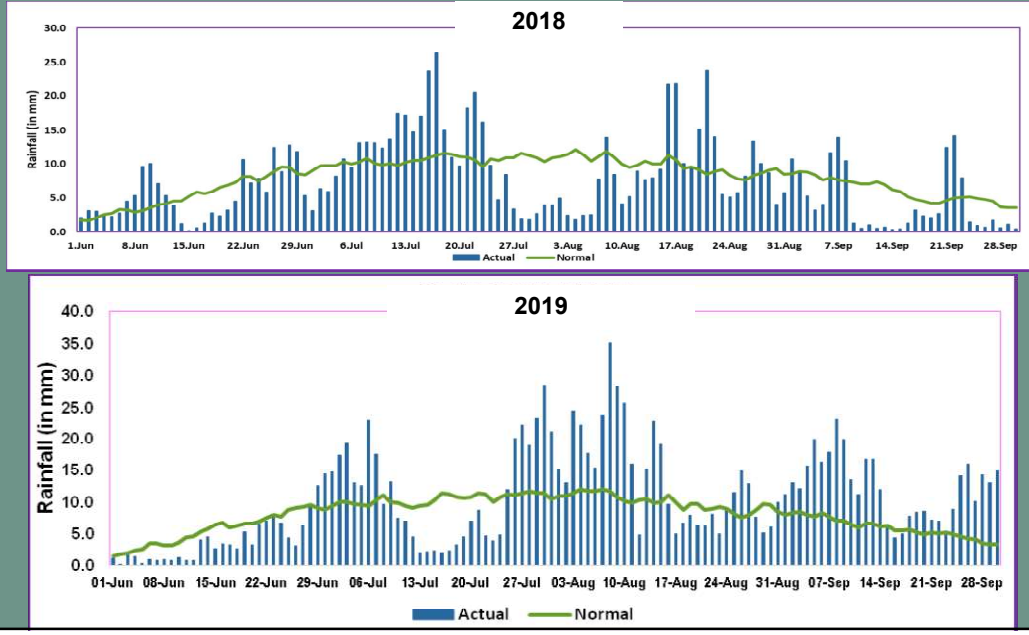
2016



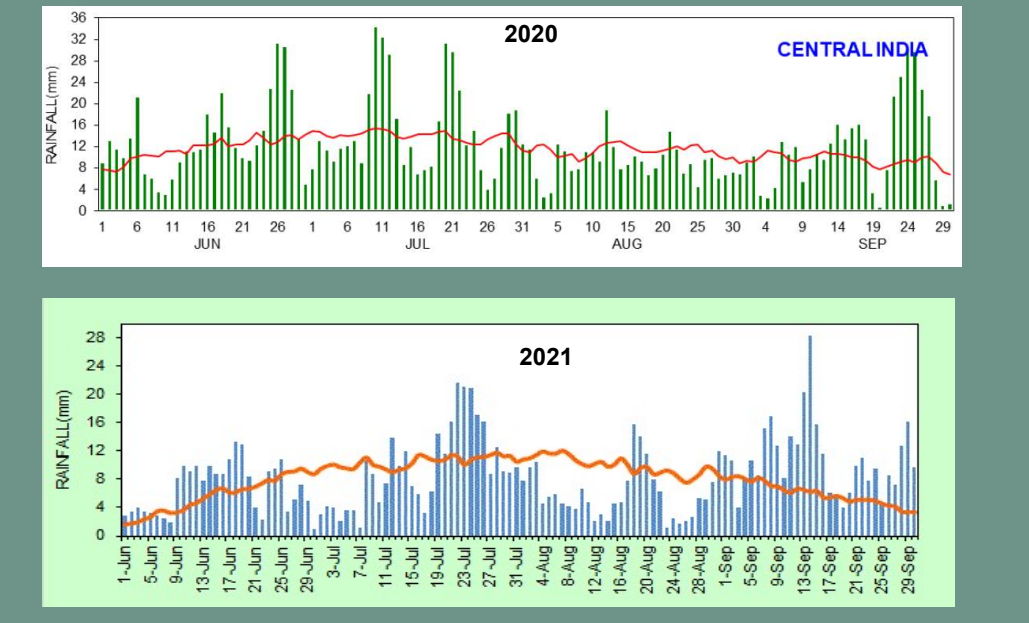
2017



Rainfall Trend in Central India



Rainfall Trend in Central India



What IISR can offer!

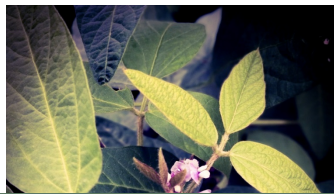
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Kunitz trypsin inhibitor

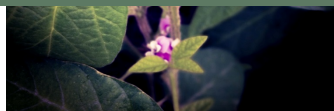
- NRC 127 NRC -142 (68.8–83.5%) trypsin inhibitor content - reduction of *Lectin protein*

Lectin protein

- Lectins are indigestible - Soybean genotypes were identified which lacks lectin in mature seeds



Anti-nutritional factors in soymeal & their genetic elimination



Stachyose

- Not readily digestible & may causes flatulence or diarrhea in non-ruminant animals. Line identified for low stachyose content.

Lipoxygenases

- Undesirable grassy & beany flavour. NRC 142 - developed - low lipoxygenase & low trypsin inhibitor content

Phytic acid

- Reduced mineral bioavailability - low phytic acid mutant lines -developed

Soy meal based food technologies



Roasted defatted soy flakes in museli preparation

Protein rich bar

Protein rich cookies and other bakery products

Soy milk analogues

Defatted soy flour

VARIETIES - 157

- ✓ Short duration
- ✓ High oleic acid
- ✓ Kunitz trypsin inhibitor free
- ✓ Drought resistant
- Water lodging resistant
- LOX Free
- Disease resistant like:
Charcoal rot resistant,
Yellow mosaic virus
resistant, Rust resistant

Specialty Soybean Varieties- IISR

**NRC 127
(2018)**



- India's 1st KTI free variety
- Maturity 102 days
- Average yield: 18 q/ha

**NRC 132
(2021)**



- Maturity: 99 days SZ, 105 EZ
- Average yield: 22.8 q/ha SZ, 16.62 q/ha EZ
- Lipoxygenase free

**NRC 142
(2021)**



- India's First Variety with null Kti and Null Lox
- Maturity: CZ 97 days
- Average yield: CZ 20q/ha
- R to YMV, MR to RAB and TLS and S to CR, Pb(ct) and MLS

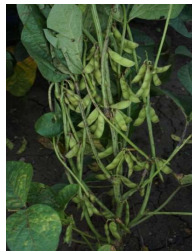
**NRC 147
(2021)**



- India's First High oleic (42%) Variety
- Maturity :96 days SZ, 100 days EZ
- Average yield: 23.6 q/ha SZ, 14.00 q/ha EZ

Some Important Soybean Varieties- IISR

**NRC 130
(2021)**



- Early Maturing
- Maturity 92 days
- Average yield: 15 q/ha
- MR to charcoal, TLS & Pod Blight

**NRC 138
(2021)**



- Maturity 93 days
- Average yield: 18q/ha
- MR to PB(ct), TLS, R to YMV, susceptible to CR, RAB and MLS

**NRC 128
(2021)**



- Maturity 110 days
- Average yield: 2269 q/ha NPZ, 18.71 q/ha EZ
- YMV & pod blight resistant
- Tolerance to water logging

**NRC 136
(2021)**








- India's first drought tolerant variety;
- Maturity 107 days
- Average yield: 17.00 q/ha ;
- HR to IBB; MR to defoliators

**NRCSL 1
(2021)**



- Maturity 107 days
- Average yield: 1706Kg/ha
- HR to IBB; MR to defoliators, Tolerant to YMV

Other Important Varieties

JS 20-79 (2014)	JS 20-34 (2014)	RVSM 2011-35 (2021)	MACS 1520 (2021)	AMS 100-39 (2021)
				
<ul style="list-style-type: none"> • 107 days • 21.25 q/ ha • Resistant to YMV and Charcoal Rot; • Resistant/ tolerant to insect pests; • High oil content (20%) 	<ul style="list-style-type: none"> • 86-88 days • 20.5 q/ha • Resistant to Charcoal Rot; moderate to high resistance to girdle beetle; moderately resistant to stem fly 	<ul style="list-style-type: none"> • Maturity 99 days • Average yield: 22Q/ha • Moderately resistant to PB(ct), TLS, Resistant to YMV, susceptible to CR, RAB and MLS 	<ul style="list-style-type: none"> • Maturity 100 days • Average yield: 22Q/ha • Resistant to charcoal rot 	<ul style="list-style-type: none"> • Maturity 92 days • Average yield: 15Q/ha • MR to charcoal, TLS & Pod Blight (ct)

Soy Food Technologies available for Commercialization

Edamame preservation technologies

- **Frozen vegetable type soybean**
- **Dried vegetable type soybean**
- **Aseptically packaged vegetable type/ retort processed vegetable type soybean**

Bakery and savory technologies (ready to eat)

- **Soy cookies**
- **Soy nuts**
- **Soy sev**
- **soy dietary cake**
- **Soy mathri**
- **Soy laddoo**



Soy Food Technologies available for Commercialization

Instant mixes

- Soy upma mix
- Soy halwa mix



Soy dairy analogues

- Soy milk
- Tofu
- Soy dahi, lassi
- Soy whey drinks
- Low fat soy mayonnaise



Technologies available for Commercialization

Microbial technology for drought alleviation & nutrient management

Commercialization of technologies

- **Commercialization/ licensing of technologies developed by IISR** :6
 - **KTI free soybean** :3
 - **Lipoxygenase free soybean** :1
 - **High oleic soybean** :1
 - **Farm machineries for soybean cultivation** :9





Strategies for ↑Productivity

Sector	Area	Problem	Present status	Future strategy
Seed	Area under the crop	<ul style="list-style-type: none"> • Poor-availability of certified / truthfully labelled seed to farmers • Demand for early maturing • Use of non descript varieties 	Poor availability of quality seed	<ul style="list-style-type: none"> • Off season multiplication of nucleus & breeder seeds for <i>Kharif</i> 2021 • Multiplication through KVKs • Effort for de-notification of non-performing old varieties
Technology	Area under the crop	Poor knowledge & adoption of technology	Huge technological gap	<ul style="list-style-type: none"> • Skill development through RKVY/KVKs • Wide spread FLD under AICRP/KVKs

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Strategies for Area Expansion

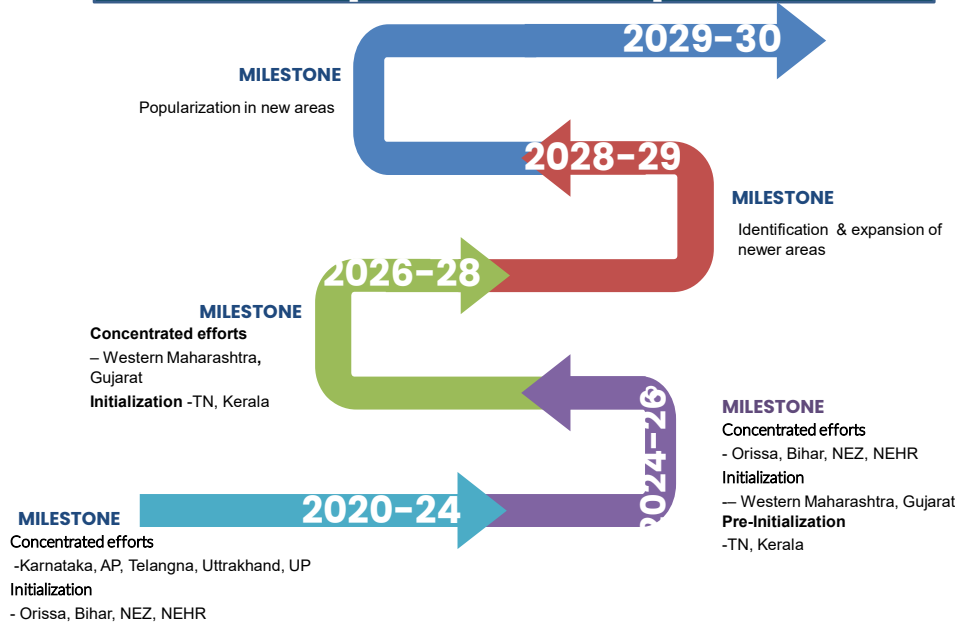
Purpose	Area	Problem	Present status	Future strategy
Oil	Uttarakhand and Tarai Region of UP, South Karnataka, Bihar, Manipur, Jharkhand, Maharashtra, Gujarat	Marketing	Contacted industry - agreed to lift material (in bulk)	<ul style="list-style-type: none"> ▪ Identify farmers in clusters ▪ Ensure seed availability (2021-30)
Food Grade Soybean	Contract farming in association with private companies	Does not enjoy separate identity	Contact with private companies	<ul style="list-style-type: none"> • Formation of hubs



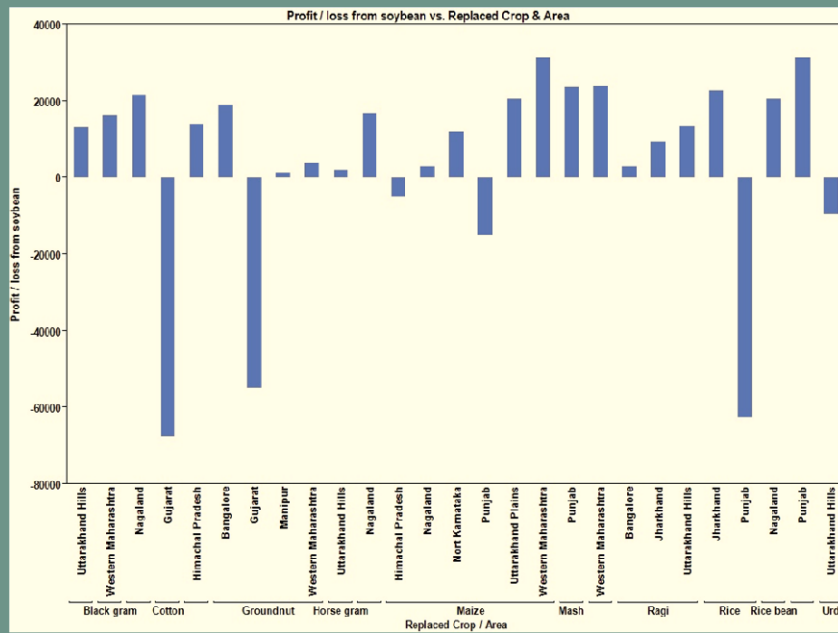
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Roadmap for Area Expansion

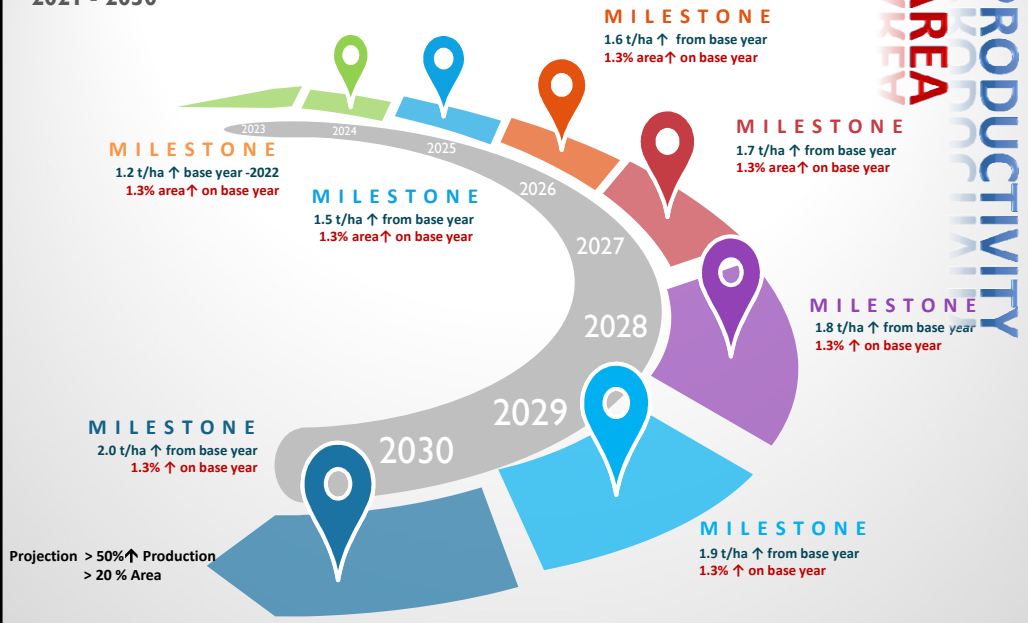



Profit/Loss from soybean vs replaces crop & Area



THE ROADMAP

2021 - 2030







Low Productivity

- ❖ Temperate crop
- ❖ Highly photo-sensitive
- ❖ Rainfed
- ❖ Poor seed replacement & Quality seed
- ❖ Multiple-cropping pattern
- ❖ Low adoption of agronomical practices

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Soybean Genetic Resources

Status

- Pre-breeding limited to *G. soja*. Utilized for YMV resistance
 - salt tolerance
 - cyst nematode
 - Antibiosis
 - **drought tolerance**
 - seed protein content
- Pre-breeding using unadapted *G. max* genotypes
 - Exotic germplasm does not survive in field in initial 2-3 years. Controlled conditions required
 - Unadapted germplasm difficult to maintain: climate, biotic stresses



Biotic Stresses: Diseases

Status

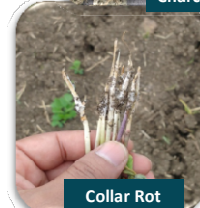
- Screening at hot spots (YMV, Rust, Charcoal Rot)
- Other diseases (Pod blight, rhizoctonia blight, frog eye leaf spot, bud blight) in field



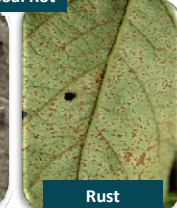
YMV



Charcoal Rot



Collar Rot



Rust

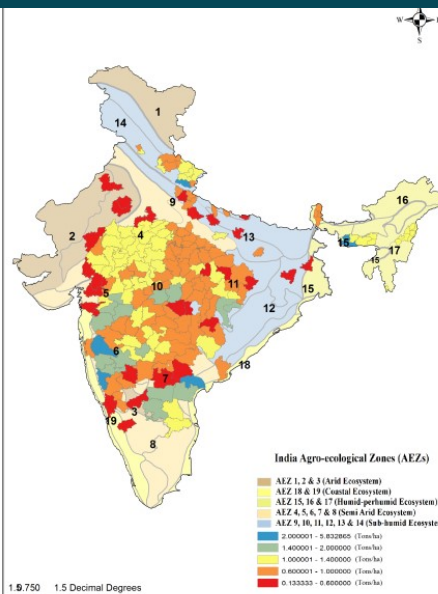
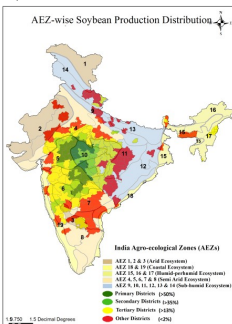
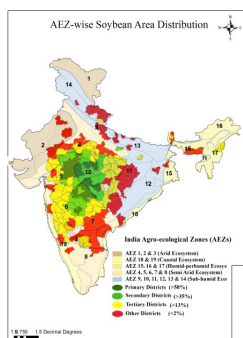
Abiotic stresses

Status

–Presently developing drought tolerant & water logging tolerant lines using summer screening, chemical desiccation screening and rain-out shelter screening



Area, Production & Productivity in India



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Marker Assisted Breeding

Status

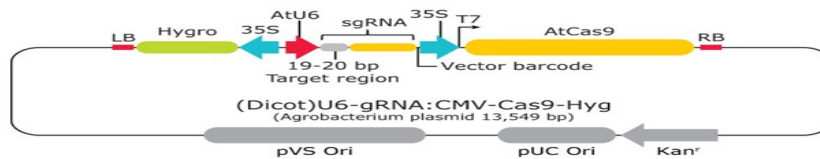
- ✓ Markers available: lox (1,2,3), KTI, Oleic acid, photoin sensitivity, long juvenility, fragrance, pod shattering
- Varieties developed: Less beany flavor (null lox 2), direct food usage (null KTI), mid-oleic acid (42%), photoin sensitive early maturing

Need

- ✓ Absence of beany flavor: triple null (null lox 1/null lox 2 / null lox 3)
- ✓ High oleic acid (~70-80%)
- ✓ Multi-trait varieties (High throughput breeding)
- ✓ Converting existing varieties
- ✓ Speed Breeding

Intervention Points

- Skilled manpower
- Infra structure for High throughput MAS & speed breeding



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Problems related to seed



- Field weathering
- Mechanical damage
- Seed longevity
- Pre-harvest sprouting

New problems



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