



# Agricultural Engineering: Achievements & Aspirations

**Dr. Shyam Narayan Jha**

**FNAAS, FIE, FNADSI, FISAE**

**DDG AE, ICAR &  
President ISAE**



## Contents of the presentation

# Presentation Encludes

01

**Introduction**

02

**Achievements**

Farm mechanization & Energy

Irrigation, soil and water engineering

Post-harvest processing and value addition

Institutional milestone

03

**Impact of developed technologies**

04

**Aspirations**

05

**Way forward**

01

## INTRODUCTION



*Sir C.V. Raman, Nobel Laureate, inspects the work of CIRCOT, Mumbai in mid-1950s.*

## The scenario change

- ▶ Sustainable food grain production – from 50MT (1951) to 316 million tons in 2022.
- ▶ Small and marginal farmers having less than one acre land- 73% increase to 88%
- ▶ Threshing of major crops- completely mechanized and overall mechanization of primary processing of food grains is 68.2%.
- ▶ Technological interventions and infrastructure development have reduced post-harvest losses by 2%, thereby saving of about **30 million tons (current value of loss Rs. 1,46,153)** of foods and **Rs. 20480** crore annually only of 45 commodities.



## **Focus on crop residues and by-products**

Animal feed, production of organic manures, extraction of bio-active compounds and energy generation



## **Retention of youth in agriculture**

- Improving comforts
- Enhancing the income
- Mechanization and towards smart mechanization



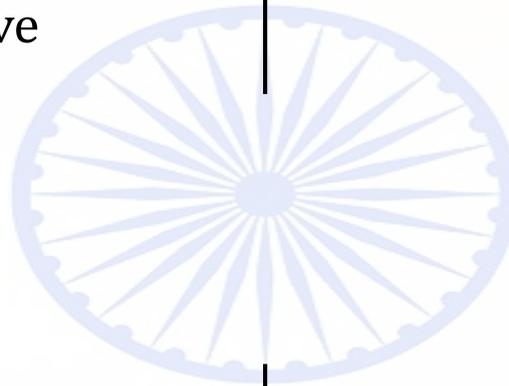
## **New technologies developed**

Drones, GPS guidance, robotics, sensors and telemetric, clean and green energy, sensor-based harvesting, storage, smart packaging, non-destructive evaluation of food safety and quality



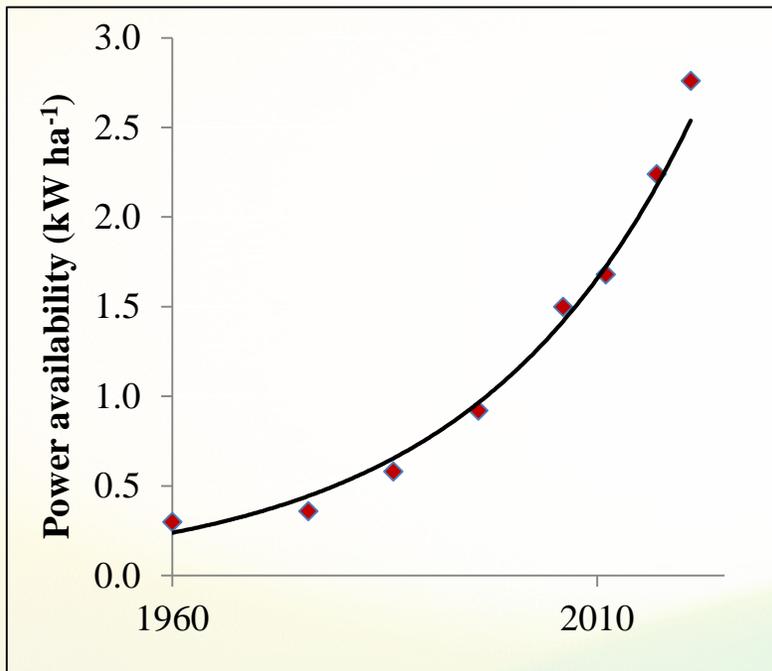
## **Advanced mechanization systems**

- Significant role in quality agriculture production and post-harvest processing
- Ensuring not only food security but also nutritional security.



## 02 Achievements

### FARM MECHANIZATION



*Power availability in Indian agriculture over the years.*

- ▶ Percentage of agricultural workers to total workers- declined from 59.1% in 1991 to 39.4% in 2021.
- ▶ Total farm power availability from all sources- increased from 0.3 kW ha<sup>-1</sup> (1960) to 2.54 kW ha<sup>-1</sup> (2019-20).
- ▶ Overall farm mechanization level in the country is 47%, much lower than China (59.5%) and Brazil (75%).
- ▶ Overall mechanization level
  - **Wheat-69%**
  - **Rice-50%**
  - **Maize-45%**
  - **Pulses-41%**
  - **Oilseeds-38%**
  - **Cotton-35%**
  - **Millet and Sugarcane-33%**

Achieved 47% overall farm mechanization of crop production in the country



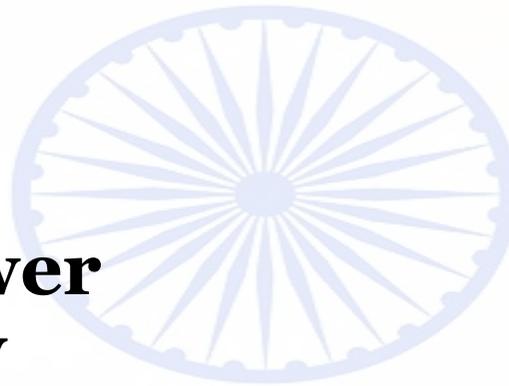
## Tractors

More than 8 million in fields today



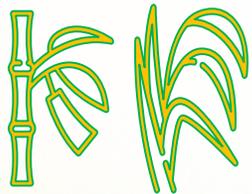
## Tractor production

Largest tractor producer in the world with about 0.6 million annual sales of tractors



## Farm power density

increasing from 0.3 kW ha<sup>-1</sup> during 1960 to 2.54 kW ha<sup>-1</sup> in 2020

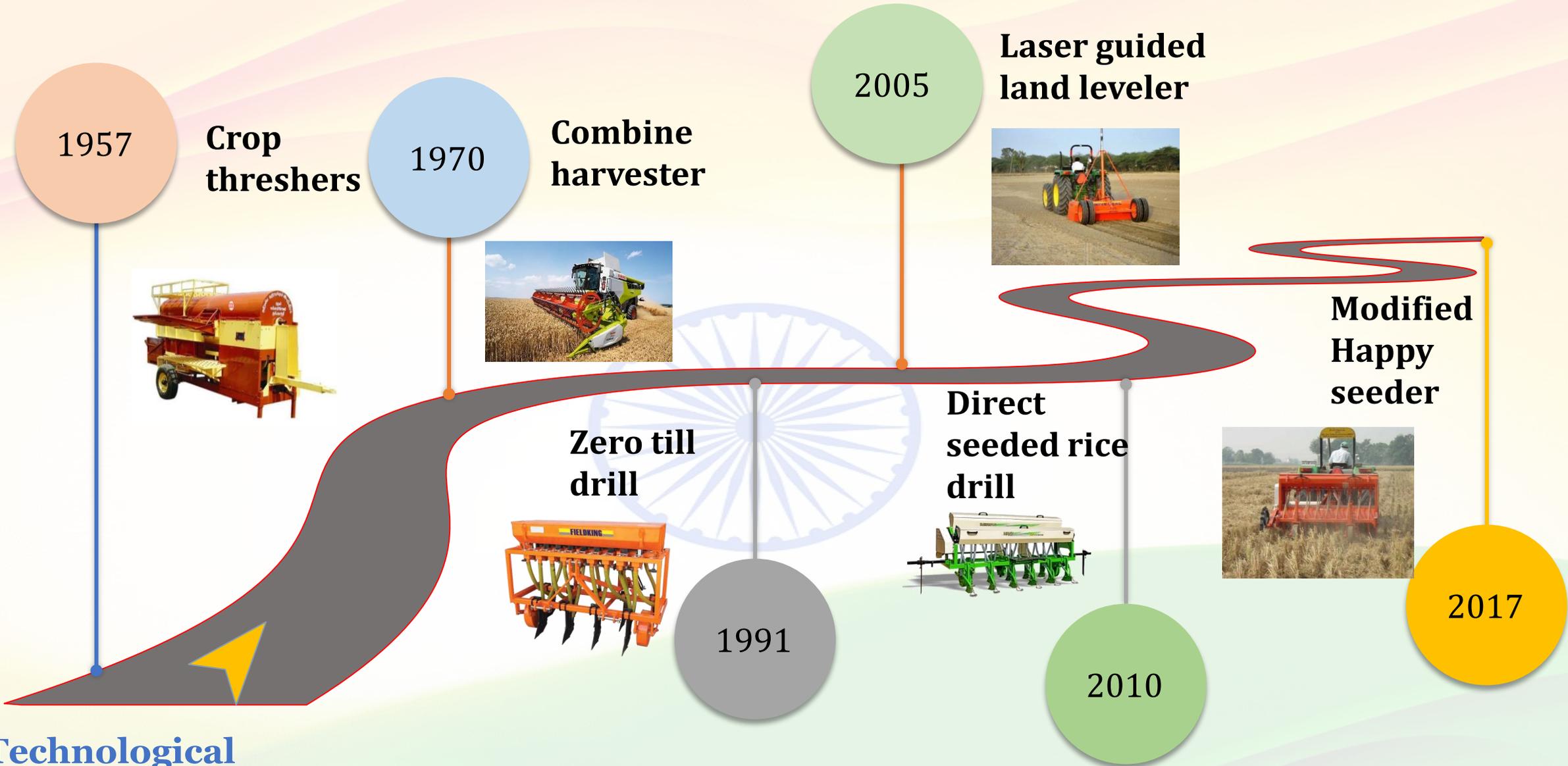


## Economic impact

licensed and commercialized of numerous technologies, machinery, tools and gadgets: economic impact of is more than Rs. 7210 crores annually



# Technological milestones



1957

**Crop threshers**



1970

**Combine harvester**



2005

**Laser guided land leveler**



1991

**Zero till drill**



**Direct seeded rice drill**



2010

**Modified Happy seeder**



2017

# Energy Revolution

- Biogas production from near zero megawatt in 2009 to about 15 MW in 2022.
- Use of sugarcane for production of ethanol and policy of blending ethanol up to 20 % by 2030 will probably be achieved before time.
- India is also becoming leader in generation and use of solar energy, however R and D on energy storage, recharging and disposing systems and generation of greener energy need acceleration.

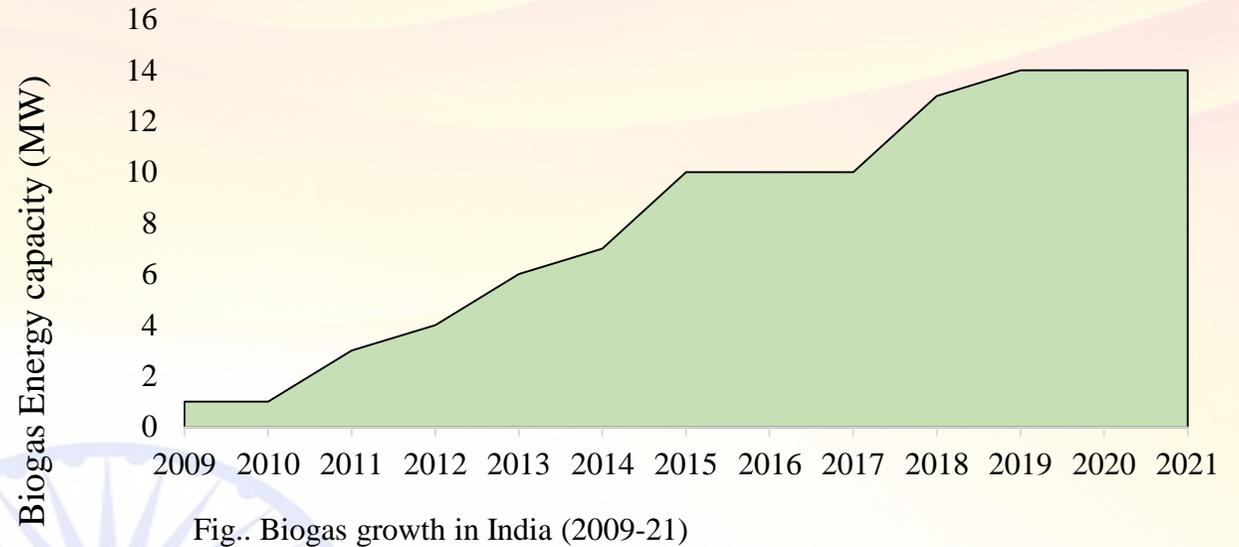
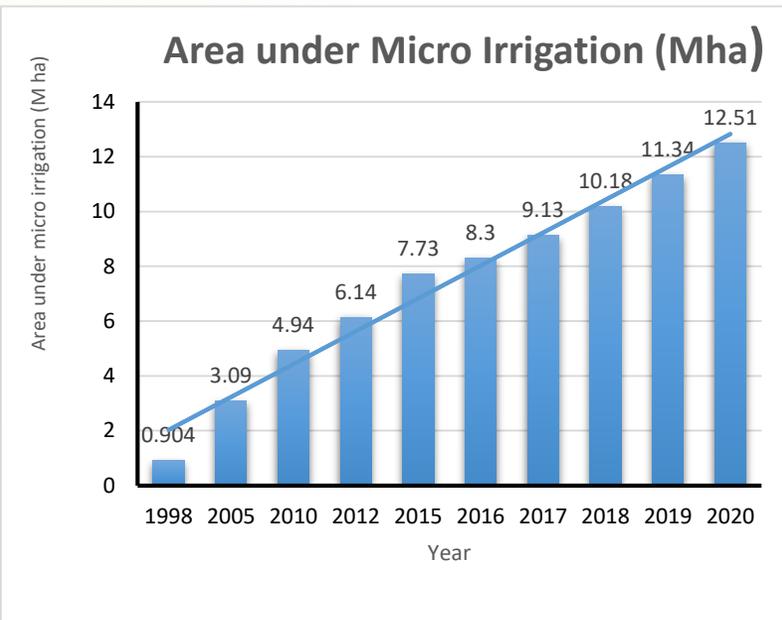


Fig. Growth in ethanol production and blending in petrol

# IRRIGATION, SOIL AND WATER ENGINEERING



- ▶ India uses over 80% of its fresh water for agriculture, the efficient use of which is paramount.
- ▶ Surface irrigation -40% irrigation efficiency; Micro-irrigation-70-90% efficiency
- ▶ Micro irrigation- wider application in spaced perennial horticultural fruit crops and has made inroads in field crops like wheat, sugarcane, vegetables, pulses etc.
- ▶ National Mission on Micro-irrigation in 2010; micro-irrigation became the part of PM Krishi *Sinchayee* Yojana (PMKSY) (2015).
- ▶ The cumulative R&D efforts enhanced the area under micro-irrigation from 0.904 million ha in 1998 to 12.91 million ha in 2021

**Pradhan Mantri Krishi  
Sinchayee Yojna**

**2015**

**2010**

**Centrally Sponsored  
Scheme on use of  
plastics in  
agriculture**

**1985**

**1977**

**National Mission  
on Micro  
Irrigation**

**First Masonry dam in  
Independent India  
(Nagarjuna Sagar  
Dam, Telangana)**

**1967**

**Introduction of  
low-density  
polyethylene  
plastic in  
irrigation system)**

**1948**

**First Multipurpose  
River Valley Project  
(Damodar Valley  
Corporation,  
Jharkhand)**

**Total irrigated area  
51 %, 716 lakh net  
irrigated area**

**Technological milestones**

# POST-HARVEST PROCESSING AND VALUE ADDITION

## I. Food crops

- ▶ The hand-operated winnowers were the first primary processing equipment introduced during 1950-55.
- ▶ Development of air screen cleaners, de-stoners, specific gravity separators and other pneumatic devices for different unit operations (By ICAR-AICRP on PHT centers and ICAR institutes )
- ▶ Drying has been one of the major methods for preventing post-harvest losses.
- ▶ The number of motor operated grain mills: 53,000 by 1970 increased over five folds by 2000.
- ▶ Roller flour mills were introduced in 1960s and their number reached to 200 by 1970; number increased by 35 times by 2000.



# Food crops



## Grain/Pulse/oilseeds

- 2000-hullers/shellers (1970) – 0.1 million; modern rice mills- 30,000 (2000) – 1.30 lakh modern rice mills (2016).
- 2019- Introduction of mobile mini rice mills
- Emery roller mill-based machines - both rice polishing and dal milling
- 2018-15,000 oil mills, 600 solvent extraction plants, 465 vegetable oil refineries and 250

## Horticultural crops

- Processed traditionally at commercial level except for drying, pickle making and some ready to eat products
- Post-harvest losses in the ranges of 6 – 18 % and 4 – 16 %, respectively in 2006 and 2014 were reported (ICAR-AICRP on PHT)
- Handling of fresh products: bamboo baskets, gunny bags or transported bulk in open carts or carriers .

## II. Fiber crops



### Cotton

- Provides 59% of raw material to the Indian textile industry and contributes 29.1% to the total textile exports.
- Contributes 4.9% to the value of agricultural output while the textile industry contributes about 4% to the GDP.
- Raw cotton is exported to the tune of 50-70 lakh bales.
- India-Largest producer of cotton and the third largest cotton exporter in the world .
- high value fabrics and machines for cotton processing have been developed and commercialized.

Cotton crop  
residue-based  
crematorium

**2019**

Cotton based  
active wear

**2017**

Specialty grade  
cotton pulp  
exceeding currency  
paper specification

**2016**

First nanocellulose  
pilot plant of Asia at  
CIRCOT Mumbai

**2014**

Indigenous  
cotton pre-  
cleaner

**1996**

First high-volume tester  
(HVI) in India for  
objective testing of  
cotton

**1987**

Commercial  
ginning machine  
manufacturing

**1961**

**1956**

First lab model  
ginning machine

**Technological milestones**

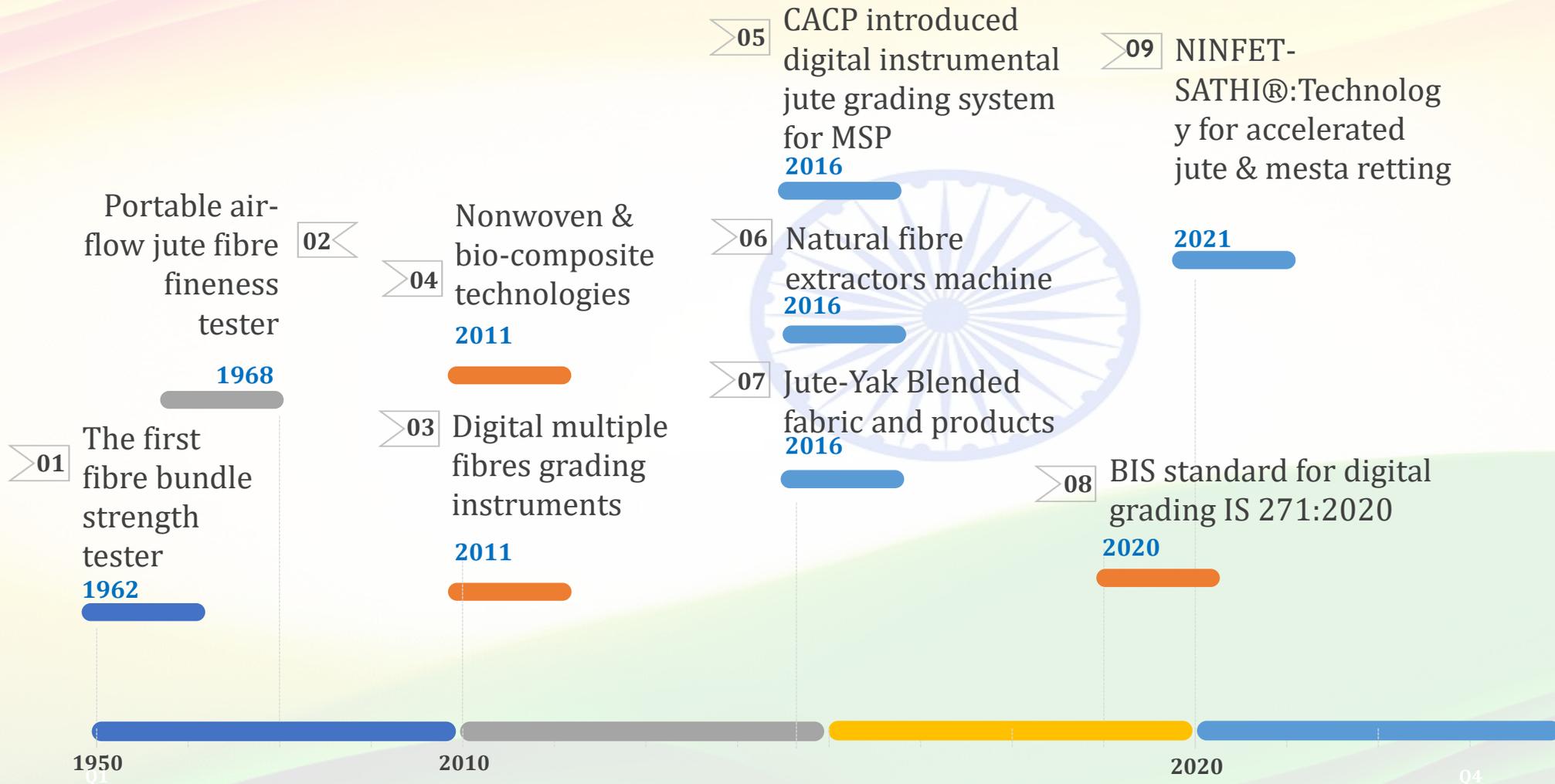
## II. Fiber crops

### Jute and other natural fiber



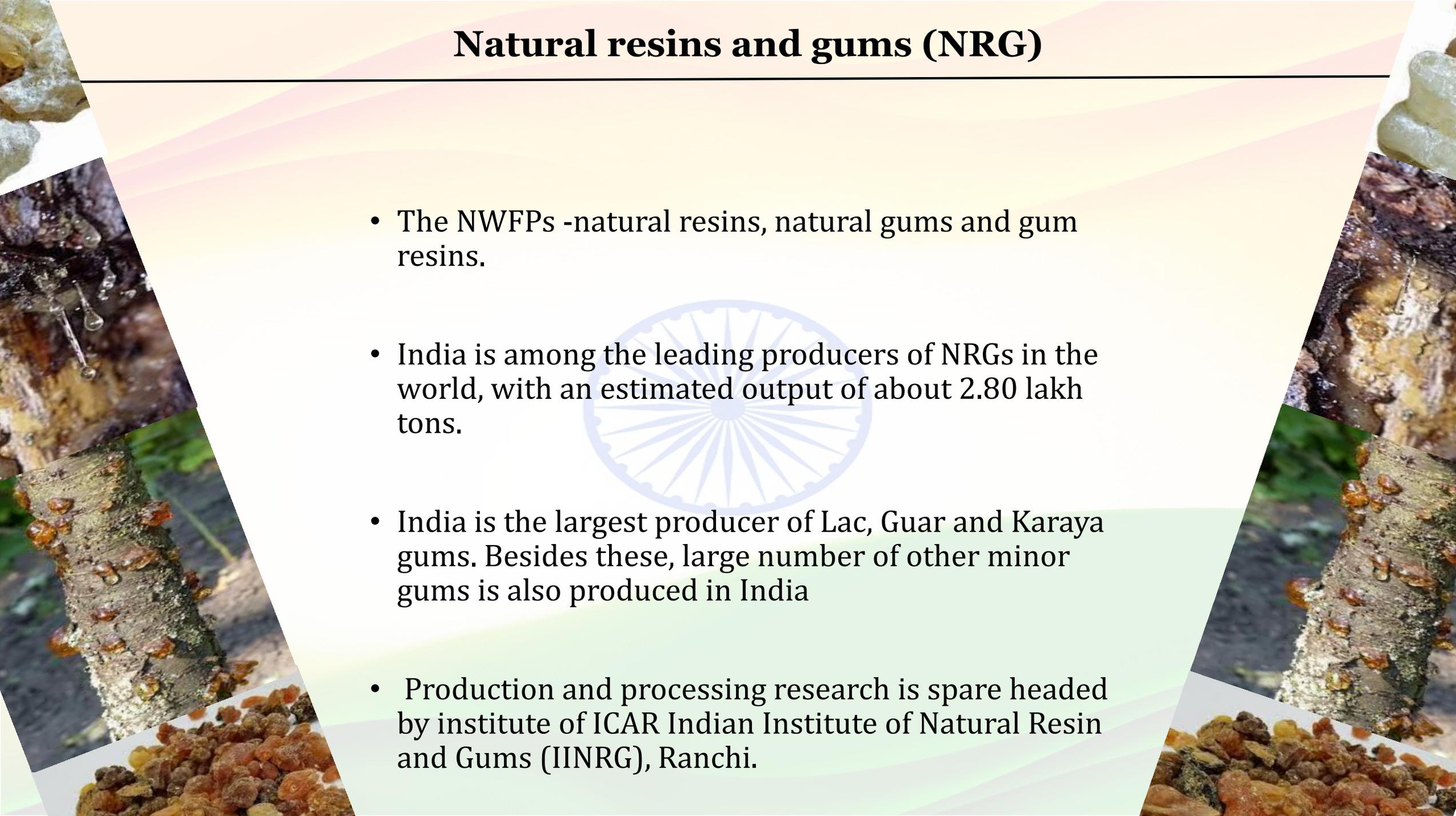
- Field preparation, seeding etc. operations are almost fully mechanized.
- Mechanization in primary processing is about 90% while that in harvesting is almost nil.
- Recently numerous value-added products of natural fibres have gained momentum in both National and export market. **About 20 % growth in Jute diversified products**

# Technological milestones

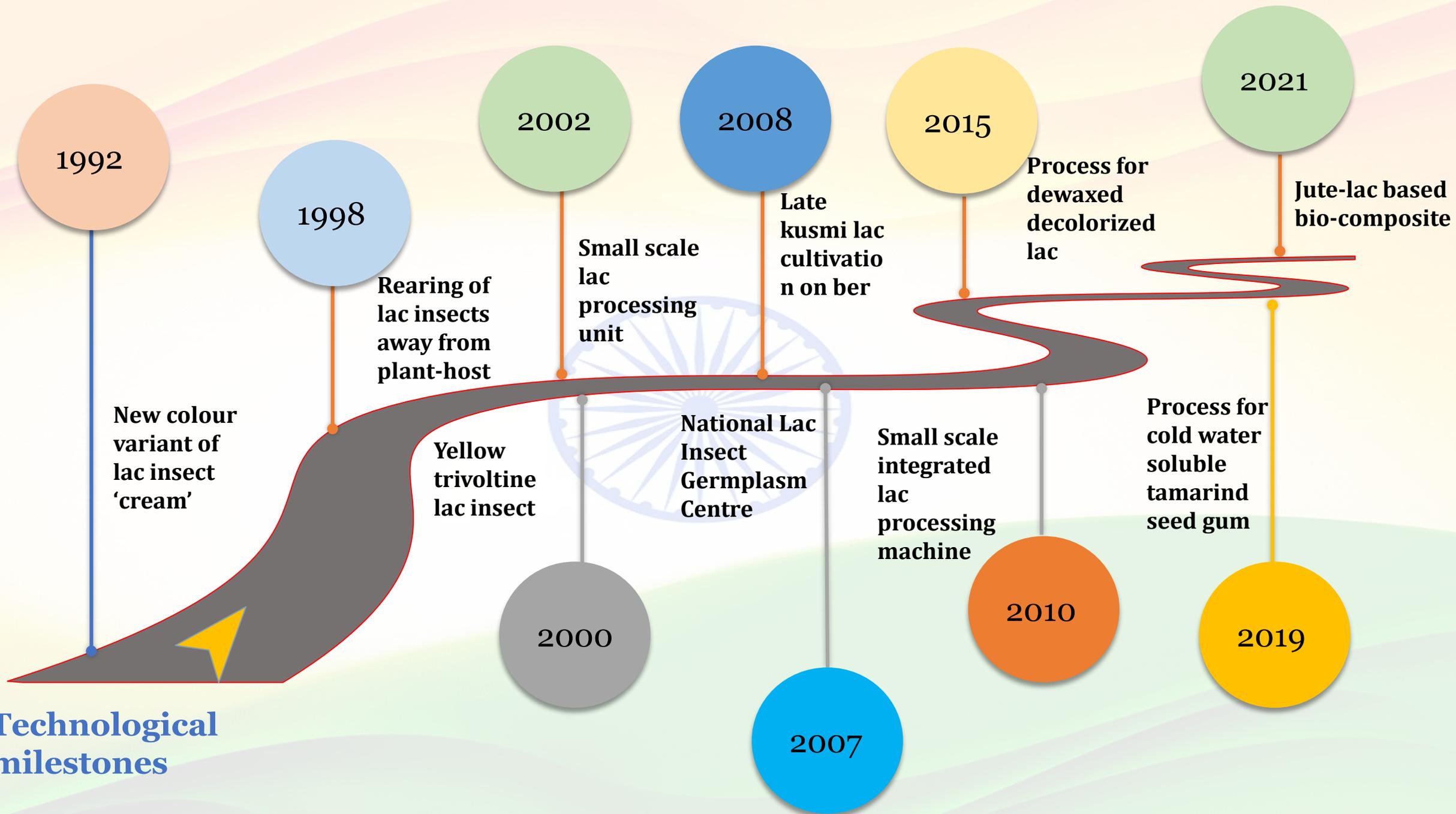


# Natural resins and gums (NRG)

- The NWFPs -natural resins, natural gums and gum resins.
- India is among the leading producers of NRGs in the world, with an estimated output of about 2.80 lakh tons.
- India is the largest producer of Lac, Guar and Karaya gums. Besides these, large number of other minor gums is also produced in India
- Production and processing research is spare headed by institute of ICAR Indian Institute of Natural Resin and Gums (IINRG), Ranchi.

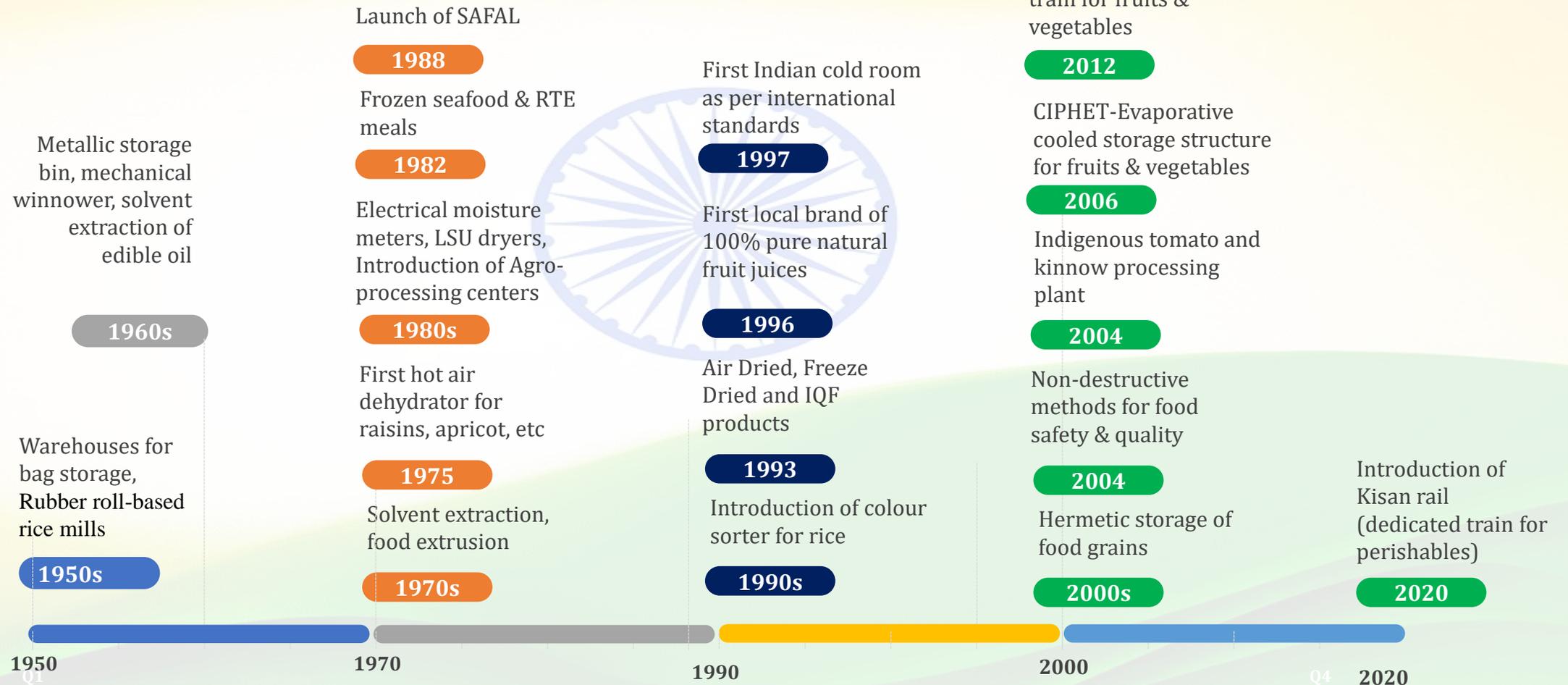


## Technological milestones



# Post-harvest processing and value addition

## Technological milestones



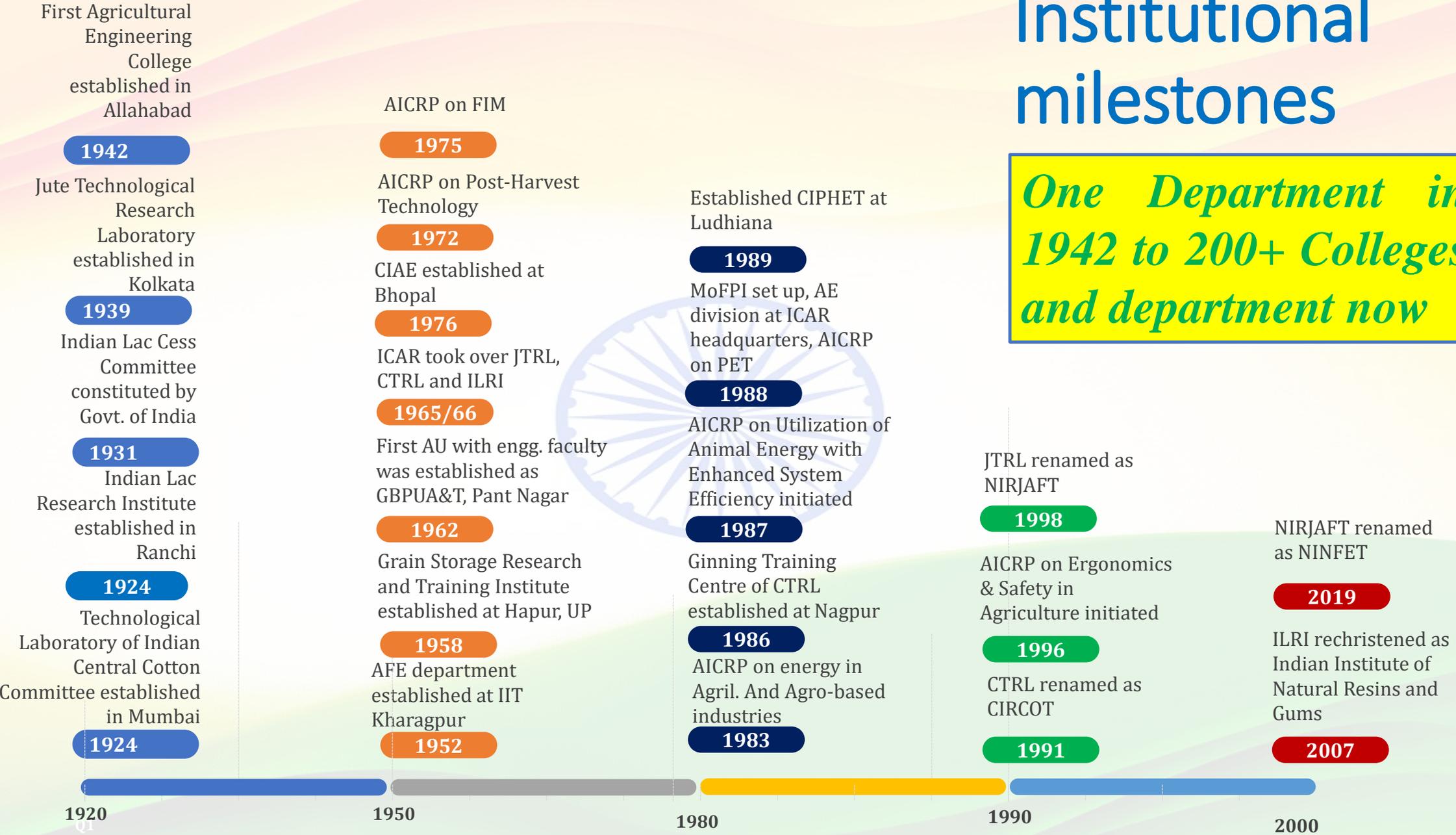
## INSTITUTIONAL MILESTONE

- ▶ Engineering interventions in non-food items such as cotton, jute, lac etc. were thought formally in pre-independent India by establishing research Institutes on these commodities.
- ▶ The formal education in agricultural engineering was initiated in 1942 by establishing
- ▶ First agricultural engineering degree programme in Allahabad Agricultural Institute, Allahabad.
- ▶ After independence country has seen several institutional milestones towards achieving agricultural mechanization and post-harvest processing and value addition.



# Institutional milestones

*One Department in 1942 to 200+ Colleges and department now*



# 03

## IMPACT OF DEVELOPED TECHNOLOGIES



S.No.	Name of equipment	Adoption (Numbers in Lakh)	Economic returns/annum (Rs Crore)
1	Cono Weeder	2.50	2612
2	Paddy drum seeder	0.65	3020
3	Inclined plate planter	1.00	1157
4	Animal drawn 3 row planter	0.70	128
5	Twin wheel hoe	1.50	115

The cumulative economic impact of selected only five farm machinery technologies is around **Rs. 7032 crore per annum.**



**Recent impact study of SMAM indicates mechanizations saves seed (15-20%), fertilizer (15-20%), time (20-30%) and reduces weed (20-40 %), labour (20-30%), and give better germination (7-25%), cropping intensity (5-20 %) and crop yield (13-23%).**

## **We are net exporters of Agricultural machinery/implement Some are listed below:**

- India's export-import trade of agro-machinery has more than doubled from US\$ 611.4 million in 2008 to US\$ 1301 million in 2017.
- India's exports of agro-machinery increased from US\$ 743.1 million in 2013 to US\$ 829.4 million in 2017 at CAGR of 1.2%.
- **The major export destinations for agro-machinery include USA (18.4%), Bangladesh (10.6%), Nepal (9.7%), Turkey (4.7%) and Sri Lanka (4.4%).**
- The USA continues to be the top exporting destination, whereas China has a major share among import destination nations.
- The tractor production of India during 2020-21 is 965231 units, of which 88621 units (9.18%) were exported.
- **Our Cotton ginning machine' export value is Rs. 300 crore annually.**
- Processed products exports have also increased by 20-30 % in last few years
- **Adoption of technologies, policy decisions and infra structure developments are shaving more than 30 million tone food per year.**

# Adoption of other developed implements, equipment and technology

- In-situ management of crop residues
- Inclined plate planters
- Threshers and Combine harvester
- Mini dal mill
- Tomato processing, kinnow waxing and grading plant
- Pedal-cum power operated air screen cleaner
- Octagonal hand maize sheller
- Makhana popping machine and value-added products
- Retting technology of jute and mesta
- Kusmi lac cultivation on *semialata* and *ber*



Machines for in-situ management of crop residues



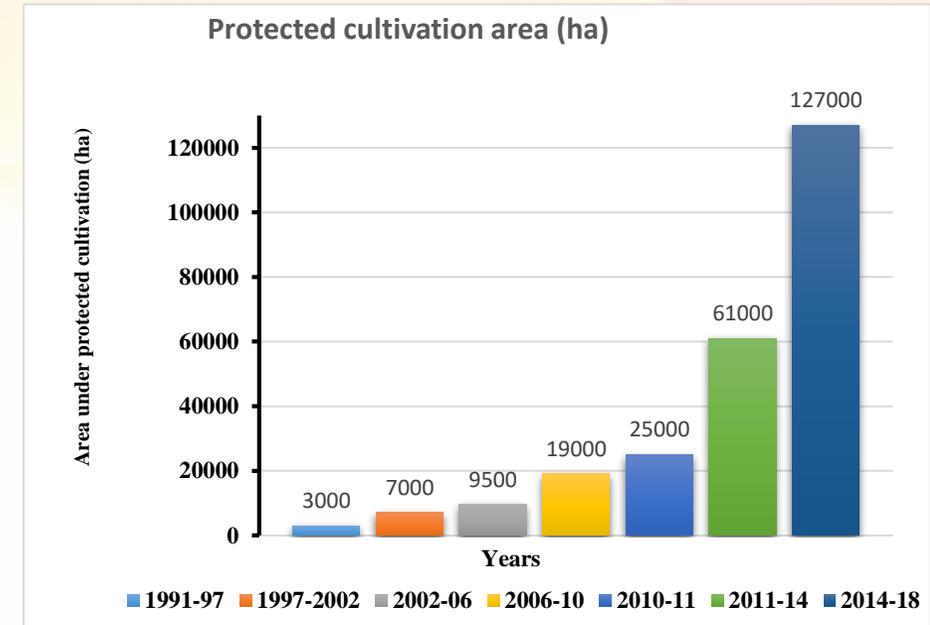
Inclined Plate planter



Makhana Popping Machine

# Protected/covered crop cultivation

- ICAR initiated AICRP on Application of Plastics in Agriculture in 1988 which was renamed to AICRP on PEASEM in 2021.
- The first polyhouse was designed and set up in 1985 at Leh (J&K). The greenhouse cultivation started during VIII plan with total area of 3211 ha.
- The total area under protected cultivation in 2018 was 2.51 lakh ha.
- On an average 80% area of protected cultivation is covered under plastic mulching and remaining under greenhouse, tunnel, shade-net and anti-hail net.



# What do We Aspire by 2047?

04

## Aspirations

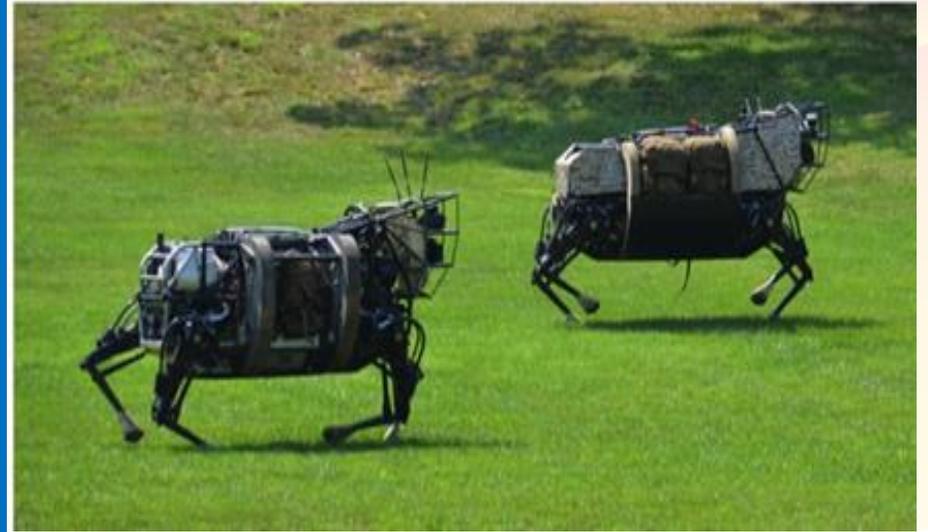


Parameters	2021	2047
Population (crore)	140	163
<b>Agri Workforce %</b>	<b>50</b>	<b>25</b>
Below poverty line %	27	05
Urbanization	35	53
<b>Income Rs/Capita</b>	<b>1,70,101</b>	<b>21,87,400</b>
Food Grain Production Mt	314	520
Fruit production Mt	102	200
Vegetable production Mt	188	400
Nutri- course cereals Mt	47	74
Milk yield kg/in-milk cow.year	1924	8000
Milk availability kg/capita	0.4	1.0

- We are celebrating *Azadee ka Amrit Mahotsav* and time between now and 2047 is called *Amrit kaal*. In this period we have to take **transformative changes** to overcome all challenges and feed the world.
- We have to shun activities leading to **5 Ds, i.e. Depletion, degradation, destruction, discard and domination in any nature**, and have to use **5 Rs i.e reduction of land, water/chemical etc. uses; and reuse, recycle, regenerate and restore** the natural resources from where you have taken.
- We need to return to the nature. We have to go to regenerative agriculture, which is inspired by eco-innovation powered **by no-carbon energy, driven by a circular economy and green infrastructure, and supported by the re-carbonization** of the terrestrial biosphere
- We must **return half of the current land under agriculture to nature, reducing food loss and waste, eating healthy diet** (e.g. non-vegetarian diet emit more carbon than vegetarian diet), narrowing the crop yield gap and/or **finding some other way of producing foods**.

## Aspirations....

- Development of Robots and AI based unmanned machines
- A village economic zone (VEZ)
- Production of food using machine
- Development of robotic cows
- Use of huge biomass/waste to green/hydrogen energy
- Establishment of National Institute Agricultural Robotics & AI



Robotic animal ([www.bioticahealth.com](http://www.bioticahealth.com))



India has seen lot of revolutions (green, white, yellow, blue etc. Now it is time of Engineering revolution in Indian Agriculture

# Research Aspirations

- Sensors, robotics and drone-led automation and mechanization
- Fruit maturity/ripening/freshness/self-life testing
- Automation in quality detection/pricing
- Fruit sorter and grader
- X-ray based fruit scanning device
- Acoustic detection of insects, sensor assisted vacuumed/hermetic fumigation chamber
- RFID-based quality tracing system for environmental monitoring and supply chain management of agri-food products
- Sensor-assisted vacuum hermetic fumigation for stored grains
- Sensor-based rapid food quality and safety detection
- 3-D food printing
- Zero tolerance for water loss.
- Green energy generation, zero carbon emitting agriculture



X-ray machine for internal quality inspection of Mango



*Determination of maturity of mango in tree  
(patent no 250880)*



*Low cost CIAE SPAD meter for input management.*



Sorting and grading machine

05

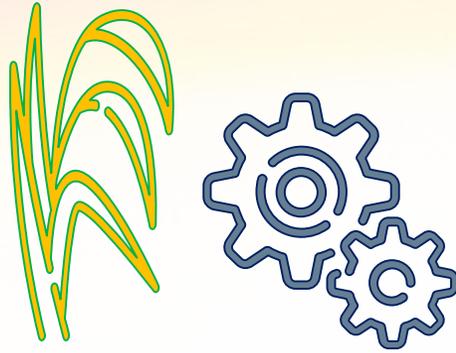


- ✓ Drastic change in course curriculum and training
- ✓ Campaign for quality students in high school
- ✓ Collaborations with international organizations/industries
- ✓ Manufacturing hub of quality and precision
- ✓ Alternative way of manufacturing foods/oil
- ✓ Agricultural Engineering Revolution



## Input from ICAR, New Delhi, India

### Agricultural Engineering SMD



**THANK YOU**

CIAE



Central Institute of Agricultural Engineering, Bhopal

- Four AICRPs & Two CRPs

CIPHET



Central Institute of Post-Harvest Engineering and Technology,  
Ludhiana

- Two AICRPs & One CRP

CIRCOT



Central Institute for Research on Cotton Technology,  
Mumbai

- One CRP

IINRG



Indian Institute of Natural Resins and Gums, Ranchi  
{National Institute of Secondary Agriculture}

- Two NWP's

NINFET



National Institute of Natural Fibre Engineering and  
Technology, Kolkata