

AGRICULTURAL ENGINEERING RESEARCH AND DEVELOPMENT IN INDIA

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- Introduction
- National Agril. Research System
- Indian Agricultural Scenario
- Agril Engineering Research and HRD
- Power of Economy and scale to small Farmers
- Technology Development & Delivery System
- Recommendations

INTRODUCTION-1

Human Beings and the Universe

•Who are we?	•Human Beings, the highest form of life
•Where are we?	•On the beautiful and dynamic planet earth – a spaceship
•Why are we here?	•Created and evolved
•What are our goals?	•Live, let others live and leave progeny
•How to go about?	•Judicious use of natural resources (WL&B) through agriculture and allied activities.
Ultimate goal is to have salvation by living a healthy and happy life	

INTRODUCTION-2

- Life is energy
- Energy comes from food
- Food comes from agriculture
- Agriculture depends on solar energy
- Solar Energy is natural & renewable

Energy is capacity for activity
(Physiological and Mechanical)

Survival, convenience and comfort of human beings depend on how best the Solar Energy is captured, transformed and utilized.

Agriculture plays VVI Role in human survival, health and happiness.

INTRODUCTION - 3

- Food
- Water
- Air



1025 Million Indian people
(17% of world population
with 2.4% land)

<p>Agriculture</p> <p>↓</p> <p>Food</p>	<p>Raw Food Materials</p> <hr/> <p>Plant based : 650 Mt</p> <p>Animal based : 100 Mt</p>
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- GOI is committed for HHF&NS through enhanced agricultural productivity, diversity and value addition, on sustainable basis.
- ICAR/NARS is MANDATED FOR THIS.

NATIONAL AGRICULTURAL RESEARCH SYSTEM

(One of the largest in the world)

ICAR

- 44 Research Institutes
- 04 Deemed Universities
- 05 National Bureaux
- 30 National Research Centres
- 12 Project Directorates
- 61 AICRPs
- 16 Research Networks
- 551 KVKs (FSC)

State & Central Universities

- 43 State Agril. Universities
 - 01 DU-AAI
 - 01 Central Agril University
 - 04 CIs with Agril. Faculty
- NARS addresses to Research, Teaching and Extension

AGRICULTURAL PROFESSIONALS IN ICAR & SAUs

(A) Scientists/Faculty

- **Sanctioned Strength : 31920 (100%)**
- **In position (2005-06) : 22534 (70.62%)**

(B) Annual Students Enrollment (23700)

- **UG (21 Disciplines) : 15,000**
- **PG (11 Disciplines) : 7,000**
- **Ph.D. (Diverse disciplines): 1,700**

TOTAL NUMBER OF EMPLOYEES IN ICAR AS ON 30TH SEPTEMBER, 2006

Type of post	Sanctioned	Filled	Vacant	% Vacant
•Scientific	6428	4184	2244	34.90
•Technical	7893	7119	774	9.80
•Administrative	4814	4355	459	9.53
•Supporting	9980	8964	1016	10.18
Total	29115	24622	4493	15.43

XTH PLAN OUTLAY OF DARE/ICAR

Plan Year	Plan Outlay, Rs. Million
2002-03	7250
2003-04	7750
2004-05	9000
2005-06	10700
2006-07	14300
Total	49000

Note:

- Annual Plan Outlay for 2007-08 = Rs. 16200 million
- One US Dollar = INR 45.00 (approximately)

INDIA AND THE WORLD

(A Comparison)

India's share in World	Indian Agricultural Scenario
•Population, 16.8%	•Arable land, 51%
•Livestock, 11.0%	•Cropping intensity, 137%
•Water, 4.2%	•Cultivated Area, 142 Mha
•Land, 2.4%	•Irrigated Area, 55 Mha
•Soil Types (45/60),75%	•Population Agril, 65%
•Major Climates (15),100%	•Contribution to GDP, 19%
•Expected life (65/80), 81%	•Share in total export, 11.2%

Agricultural Scenario in India

Geographical Area and Agricultural Land

•Total geographical area	328.7 Mha
•Net cropped area under	142.8 Mha
•Grossed cropped are under	190.0 Mha
•Net area under irrigation	55.0 Mha
•Land distribution pattern	
•Large,> 10ha (17ha)	15%
•Medium 4-10 ha (6ha)	25%
•Semi-medium 2-4 ha(2.7ha)	24%
•Small, 1-2 ha(1.4ha)	19%
•Marginal > 1ha(0.4ha)	17%

INDIAN AGRICULTURE

(Role of Agril. Engineering)

(A) Major Issues

- **Low Productivity**
- **Low Profitability**

(B) Some of the Reasons

- **Low Land Holdings**
- **Low Level of Inputs**
- **Low Level of Mechanization**

Engineering intervention in agriculture would facilitate higher productivity and profitability on sustainable basis.

Operation in Production and Post-Production Agriculture

Plant Based (Food & Fibre)

PRODUCTION TECHNOLOGY (PT)

- | | |
|---|---|
| <ul style="list-style-type: none">• Land Levelling• Seed bed Preparation• Sowing and Planting• Irrigation and Fertilization• Weed Control and P.P.• Harvesting and threshing | <ul style="list-style-type: none">• Cleaning and grading• Handling and transport• Drying and storage• Processing and value addition• Packaging, transport and marketing• Preparation for utilization |
|---|---|

AUGMENTATION OF FOOD PRODUCTION IN INDIA THROUGH ENGINEERING INTERVENTIONS

Activity/Intervention	Augmentation of total food production, %
•Farm Mechanization	10-15%
•Post-Harvest Management	5-10%
•Value Addition	25-400%

Contribution of Agricultural Mechanization in India

•Saving in seed	15-20%
•Saving in fertilizer	15-20%
•Saving in time	20-30%
•Reduction in labours	20-30%
•Increase in cropping intensity	5-20%
•Higher productivity	10-15%
•Reduction in drudgery of farm workers especially that of women	

ENERGY SOURCES AND FARM POWER

Energy Sources	Farm Power
<ul style="list-style-type: none">• Conventional or commercial (coal, water, petroleum, gas & electricity)• Non-conventional or Renewable (solar, wind, biomass and animate)	<ul style="list-style-type: none">• Animate (humans and animals)• Mechanical (Tractor, power tiller, diesel & electricity)• Renewable (Solar, biogas, produce gas)
<p>High and rising cost of depleting petroleum and irregular supply of electricity in rural sector compel the development and promotion of RES based gadgets and power supply for better rural living</p>	

Percent contribution of different power sources in Indian Agriculture (2005-06)

• Agricultural worker	6	Total power = 1.5 kw./ha
• Draught animals	8	
• Tractor	47	
• Power tiller	01	
• Diesel engine	18	
• Electric motors	20	

Present population and annual production of some of the farm implements and machines

Implements/machines	Annual sales	Population in 2004-05, Million
Tractor	1.75 lakhs	3.00
Power tiller	10000	0.130
Combines	600	0.006
Irrigation and diesel pumps	7.00 lakhs	32.00
Power sprayer/duster	4.5 lakhs	0.150
Seed drills	2.5 lakhs	1.700
Threshers	4.0lakhs	2.500

model need to be set up in production catchments to establish the benefits of mechanization of farm operations and post-harvest for increasing production and productivity and employment generation. The employment generation will be through increasing cropping intensity and creation of secondary business of agro-processing, value addition and marketing at rural level.

Mechanization Package for Agriculture

Use of appropriate implements & machinery would result in:

- 15-20% Seed saving
- 15-20% Fertilizer saving
- 5-20% Increase in C. I.
- 10-15% higher productivity



Mould Board Plough

Cost: Rs.15,000-16,000
Capacity: 0.2 ha/hour
Cost of Operation: Rs.1050/ha



Seed-cum-Fertilizer Drill

Cost: Rs.4500
Capacity: .18-0.24 ha/hour
Operation: Rs.165/ha

•Region and crop-wise mechanization package consisting of animal drawn and tractor operated implements and equipment have been developed.



Inclined Plate Planter

Cost: Rs.16,000
Capacity: 0.40-0.50 ha/hour
Cost of Operation:Rs.740/ha

Resource Conservation Equipment & Technology

•Laser land leveler	•30-50% saving in water
•Rotavator	•50% fuel saving & better quality seed bed
•Zero till drill/minimum till drill/ multipurpose tool bar/ raised bed planter	•5-10% increase in yield and saving of Rs. 2000- 3000/ha.
•Pressurized irrigation	•20-30% saving in water
•Rotary power weeder	•20-30% saving in time and labour
•Vertical conveyor reaper/ combine	•Timely harvesting, more yield
•Multi-crop thresher	•50% saving in labour and time and 54% saving in cost of threshing
Straw combine	•Recovers 50% straw and also 70-100 kg grain/ha resulting into an average saving of Rs. 1250/ha.
•Straw baler	•Makes bales and checks environmental pollution
•Straw cutter-cum-spreader	•Cuts and spreads the straw evenly and helps in sowing by zero till drill.
•Improved manual harvester for mango & kinnow	•No damage to fruit and higher capacity

Laser Land Leveler



- **30-50% saving in water and 5-10% higher yield**
- **Cost is between 4-5 Lakhs. Becoming popular among small and medium Farmers on custom-hire basis**

Zero Till Drill



Saves Rs. 2000-3000/ha on account of time and fuel

Zero till drill



Benefits

- 50 to 65% saving in time in land preparation and sowing.
- 40-65% reduction in cost of operation
- Saves Rs. 2000-3000/ha.
- Yield increase by 5%
- Saving in fuel by 30 %

Potential

- Total wheat area =26 Mha
- If only 11Mha is sown by zero till, total saving expected is Rs.2200-3300 crore.
- Average Field capacity is 3ha/day (sowing time=20 days)
- Number of drills needed=1.8 lakhs
- Funds needed = Rs. 360 crores
- Saving in cost of production =Rs.2200 crores
- Increase in wheat production= 2Mt.



Manual Rice Transplanting



Self propelled 6-row Rice Transplanting



Sprinkler Irrigation



Drip Irrigation



CIAE Twin Wheel Hoe

Manual Weeder



Power Weeder



Power Sprayer



Manual Harvesting



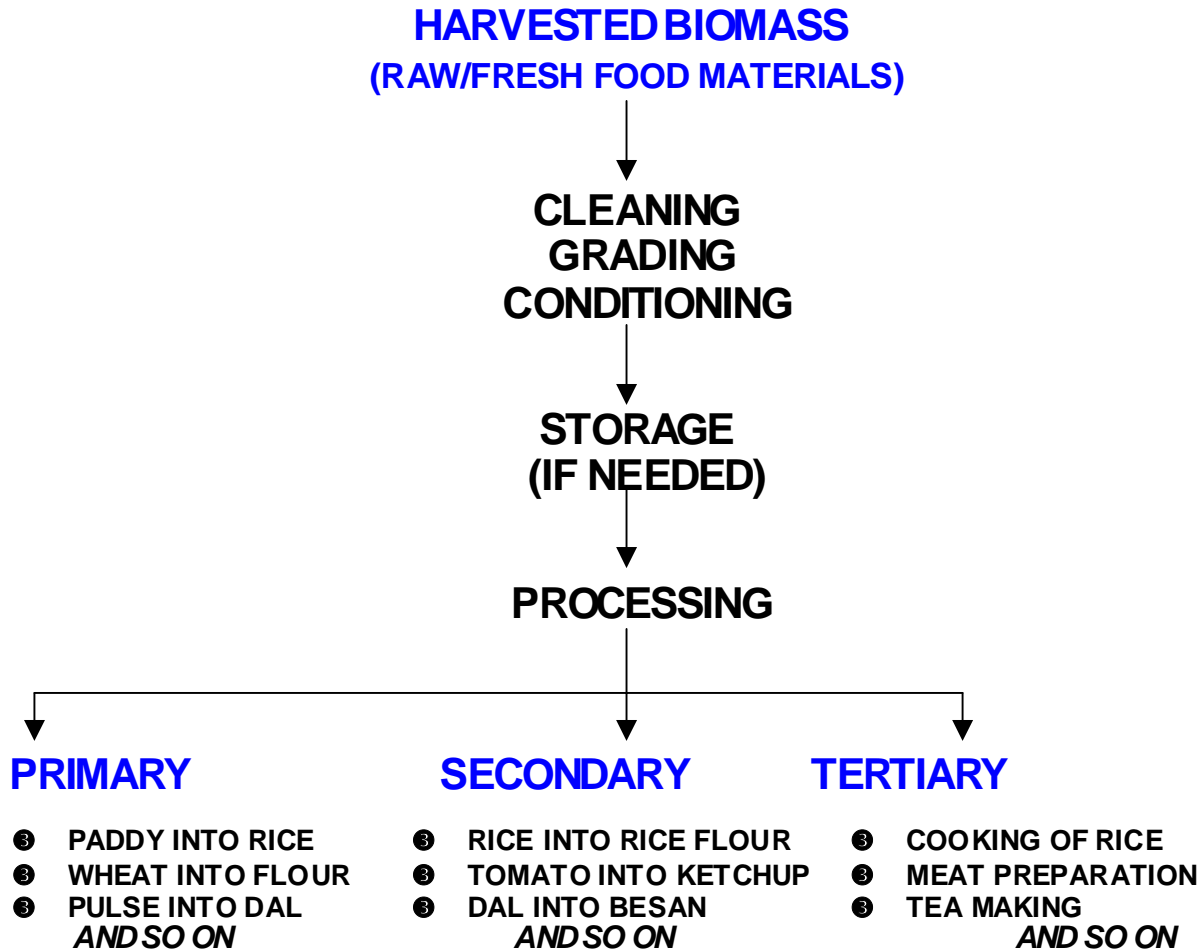
**SELF PROPELLED VERTICAL CONVEYOR
REAPER**



Combine Harvester in Operation

Combine Harbesting

PROCESSING AND VALUE ADDITION



Estimated value additions to the raw food materials through primary and secondary/tertiary processing in India are 75% and 25% respectively.

**AT EVERY STAGE OF PROCESSING
VALUE IS ADDED TO THE PRODUCT**

Flow diagram of value addition to the harvested biomass of plant and animal origin

Agro-Processing

- **Processing and value addition in the Production Catchment for:**
 - **Loss Prevention**
 - **Income Generation**
 - **Better Quality Products**
 - **By-products Utilization**
 - **Less Transportation**

Resulting in better human, animal and soil health

AGRO PROCESSING CENTRE



An investment of Rs. One lakh can generate employment for 1-2 persons and an income of Rs. 3000-5000/month for the entrepreneur

Soybean (6-7 Mt)

Conventional Products

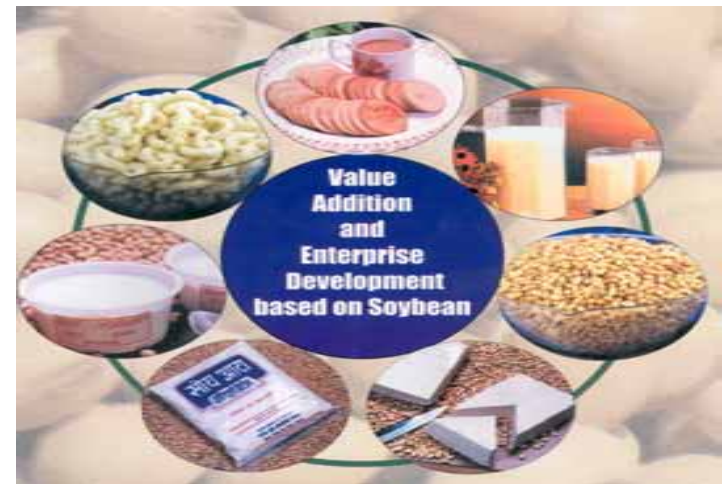
- Oil and Cake

Diversified Products (whole soybean based)

- Soy-based dairy analogs
- Soy fortified baked products
- Roasted and fermented soy snacks
- Soy-cereal-millet based baked/ extruded RTE foods
- Dietary fibre from soyhull & okara

Potential Value Addition

- Fullfat Soyflour : 40%
- Soymilk : 150%
- Soypaneer : 400%





Sugarcane based diversified products for small and micro enterprises in rural sector.

CASE STUDY

Techno-economic feasibility analysis of a typical Agro-Processing Centre in a production catchment in Ludhiana, Punjab

- Processing of paddy (100t), wheat (400t), oilseeds (75t), spices (4t) and cotton carding (7.5t)

- Total Investment : Rs. 5,40,000

- Annual profit : Rs. 3,90,000

- Monthly profit : Rs. 32,500

- Payback period : 1.4. Years

- Breakeven point : 1050 h

- Employment : Four Persons

- Value Addition: Rs 2800/t of paddy

- Additional Income to farmer Rs. 1800/t



Entrepreneurship Development in Soy-Dairy Analogs



**Cost of 200 l/day(8h) mill plant
or
50 kg soypaneer plant per day= Rs. 2.7 lakhs**

Some of the Women friendly Post Harvest Tools and Machines - 1



CIAE Tubular Maize Sheller

Cost: Rs.30=00
Capacity:- 18-20 kg/h
Cost of Operation:Rs.60/q



Cost: Rs. 750=00
Capacity: 30-40kg/h
Cost of Operation:Rs.25/q



Cost: Rs. 900=00
Capacity: 60-70kg/h
Cost of Operation:Rs.15-20/q

Hanging type grain cleaner



Cost: Rs.2000=00

Capacity:- 150-200 kg/h

Cost of Operation:Rs.5-6/q

Some of the Women friendly Post Harvest Tools and Machines-2



Flour sifter

Cost: Rs.22000=00

Capacity:- 80-120 kg/h

Cost of Operation:Rs.15/q

Dal mill



Cost: Rs.4000=00

Capacity:- 100kg dal/h

Cost of Operation:Rs.15-20/q

Renewable Energy Technology and Gadgets for Rural Sector

For Domestic Application	For Agro-industrial Application
<ul style="list-style-type: none"> •Biogas Plant •Biomass Cook Stove •Solar Cooker •Solar Water Heater •Solar Dryer 	<ul style="list-style-type: none"> •Solar Photovoltaic Pump •Solar Tunnel Dryer •Biomass gasifier •Biogas slurry as manure <div data-bbox="1300 394 1605 658" data-label="Image"> <p>Improved Cookstove</p> <p><i>It has higher thermal efficiency and less smoke emission as compared to traditional cook stoves.</i></p> </div>



Biogas Plant



Solar Cooker



Photovoltaic Pump

Thermal and Motive Energy for Agricultural Production and Processing in Rural Sector

- **India produces about 500 Mt of crop residues annually**
- **25% of crop residue (125 Mt) is available for energy generation (12500 MW) in rural sector**
- **Gasification based system/ technology costing Rs. 10-15 million/MW is available**



Producer gas system installed in an industry near Anand (Gujarat) for chicory roasting

BIOFUELS

National Policy on Biofuels targets the replacement of fossil fuels by biofuels to the extent of:

- 5% by 2012
- 10% by 2017
- 20% Beyond 2017

- Biofuels are liquid or gaseous fuels produced from biomass
- Biomass are biodegradable products, residues and wastes from agriculture, forestry and related industries
- The major biofuels are biodiesel, bioethanol, biogas & producer gas

GOI is giving more emphasis on Biodiesel production through **Jatropha Curcas** and **Pongamia Pinnata** plantations on non-agricultural lands and its subsequent processing and utilization

Production and Productivity Potential of Jatropha Seed & Oil



- Plant population
- (2 m x 2 m) : 2500
- Fruiting starts : 2nd year
- Fruiting stabilizes : 5-6 years
- Fruiting continues: 40-50 years
- Jatropha seed : 4-5 kg/plant
- Oil content : 30-35%
- Oil yield : 3.5-4.0 t/ha



Jatropha Plant and Fruits



Jatropha seed



Jatropha seed and kernel



•Sustainable production, conversion and application of biofuels are in the National Interest

Jatropha Oil & Cake

Infrastructure for R&D and HRD in Agril. Engg. in India

ICAR Institutions & COAE in SAUs	AICRPs
•CIAE, Bhopal	•FIM, 23 Centres
•CIPHET, Ludhiana	•UAE, 08 Centres
•CIRCOT, Mumbai	•RES, 15 Centre
•ILRI, Ranchi	•ESA, 06 Centres
•NIRJAFT, Kolkata	•PHT, 33 Centres
•IASRI, New Delhi	•APA, 09 Centres
•COAE in SAUs and CIs	

Intake Capacity of Agril.Engineering Institutions in India and Training Areas

(A) Number of Institutions/Colleges offering

- **B-Tech/BE, 22 (890 students)**
- **M.Tech/ME, 16 (290 students)**
- **Ph. D., 07 (75 students)**

(B) Trainings are offered in different disciplines of Agril. Engg.

- **FMP, I&DE, Green House Technology**
- **Renewable Energy Management**
- **PHE&T for Food and Fibre Crops**
- **Entrepreneurship Development**
- **Livestock Products Technology**

REDEFINING THE ROLE OF AGRICULTURAL ENGINEERING

Major Challenges in the 21st Century

- Protection of world natural resources such as soil, water, biodiversity, environmental and energy.
- Development of engineering system that could monitor, replace or intervene in the function and operation of living beings.
- Availability of adequate and safe food to ever increasing local and global population

Responses to Paradigm Changes in Agril

- Agril. Engg. needs to be redefined to enhance its scope to biological and environmental engineering which is rapidly evolving with advancements in biological sensors, nanotechnology, biotechnology and molecular biology.
- Engineering intervention in agriculture facilitates higher productivity and profitability and reduced drudgery of farm workers
- Agril. Traps and converts solar energy into chemical energy as harvested biomass which is made edible through PHM & VA activities.

Strategy for Strengthening Agricultural Engineering Research and Delivery System

- Framework for technology development and delivery involving scientists, farmers, industry, extension functionary, financial institutions, etc.
- Technology development and delivery system for farm mechanization and renewable energy application.
- Technology development and delivery model for PHM and VA.

Technology Development and Delivery System (TD&DS)

<i>Activities</i>	<i>Institutions</i>	<i>Outputs</i>
•Basic and Strategic Research	•ICAR Institutes, Universities/CIs, SAUs, AICRPs, Private Sector	•Principles, Processes & Methodology (Knowledge)
•Applied and Adaptive Research	•SAU, AICRPs, Private Sector	•Products & Technology
•Technology Assessment, Refinement and Demonstration	•ZRS, KVKs, ATMAs, SAUs, Coops, NGO, SHG, PRIs	•Location and commodity specific technology
•Line Department	•Block, Panchayat, Village Farmers	•Higher agricultural productivity and profitability

FARM MECHANIZATION AND RENEWABLE ENERGY FOR AGRIUCTURE (TD&DS)

Activities	Institutions	Outputs
<ul style="list-style-type: none"> •Basic and Strategic Research (Biomaterials, Mechanics, Ergonomics, Metallury) 	<ul style="list-style-type: none"> •ICAR Institutes, SAUs, CIs & FMM 	<ul style="list-style-type: none"> •Better Materials • Precise and Efficient Mechanism •Analytical techniques and DSS •Design Methodology & Manufacturing Processes.
<ul style="list-style-type: none"> •Applied and Adaptive Research (Efficient and Precision Machines and RES based Gadget & Appliances) 	<ul style="list-style-type: none"> •ICAR Institutes, SAUs, CIs, FMM 	<ul style="list-style-type: none"> •Tools, Implements, Equipments, Prime-Movers, RE Gadgets & Appliances, Mechanization Management
<ul style="list-style-type: none"> •Multilocation farm trials and demonstrations 	<ul style="list-style-type: none"> •AICRPs, SAUs, KVKs & ICAR Institutes 	<ul style="list-style-type: none"> •Location and commodity specific tools technology
<ul style="list-style-type: none"> •ED, Manufacture and supply of tools and machines 	<ul style="list-style-type: none"> •AICRPs, SAUs, KVKs, ICAR Institutes & Industry 	<ul style="list-style-type: none"> •Availability of appropriate farm tools and machines and RE Gadgets to farmers

Development of Models for PHM and Value Addition (TD&DS)

Activities	Institutions	Outputs
<ul style="list-style-type: none"> •Basic and Strategic Research (Varietal characteristics, PH Physiology and Ecology, food biochemistry and nutritional profile) 	<ul style="list-style-type: none"> •ICAR Institutes, SAUs, CIs 	<ul style="list-style-type: none"> • Novel products, nutraceuticals, processes and equipment, quality and safety, product composition, analytical technique and policy research
<ul style="list-style-type: none"> •Applied and Adaptive Research (New products and processes, byproducts utilization) 	<ul style="list-style-type: none"> •AICRPs, PHTs, SAUs, ICAR Institutes, Cooperatives, KVKs, NGOs, Agro-food processing industry 	<ul style="list-style-type: none"> •Commodity and location specific technology alongwith quality and safety parameters
<ul style="list-style-type: none"> •Demonstration, market search & standardization 	<ul style="list-style-type: none"> •AICRPs (PHT), NGOs, SHGs, Cooperatives, KVKs, SAUs, ICAR Institutes 	<ul style="list-style-type: none"> •Techno-economically viable pilot plants and DPRs
<ul style="list-style-type: none"> •Training and ED 	<ul style="list-style-type: none"> •AICRPs (PHT & APA), SAUs & KVKs, <div style="text-align: center;">↓</div> Farmers Entrepreneurs 	<ul style="list-style-type: none"> •Availability of appropriate post harvest processing and VA technologies

Power of Economy & Scale (Options)

- | | |
|---|--|
| <ul style="list-style-type: none">• Self Help Groups• Cooperatives• Contract Farming | <ul style="list-style-type: none">• Farm Machinery Service Centre• Agro-Processing Centre• Agri.Marketing |
|---|--|

- **Farm Schools for FTF Contact & Learning**
- **Farm Science Manager**
- **Villager Knowledge Centre**
- **Farm Science & Agro-Industry Centre**
- **Contract Farming Council**

**Leading to Small Farm Management Revolution
Resulting in Better Farm Outputs and Quality of Life**

Suggestions for Promotion of Agricultural Mechanization in Different States India

- Agril Engineering Directorate/Nodal Agency in each State/UT
- Agril. Machinery manufacturing workshop in each state
- FM Manufacturing Units within 30-50 Km radius
- Agril. Machinery manufacturers association at national & state levels
- Agro-processing centre in production catchment
- A mixed source of farm power
- RES based gadget and appliances need to be promoted

Highlights of Major Achievements of ICAR

- **Green Revolution**
 - (215 Mt of food grains)
- **Yellow Revolution**
 - (25 Mt of Oilseeds)
- **White Revolution**
 - (91 Mt of Milk)
- **Blue Revolution**
 - (6 Mt of fishes)
- **Horticultural Revolution**
 - (150 Mt of fruits & Vegetables)

All these are leading India towards

Evergreen / Rainbow Revolution

Household F & NS

Developed Nation by 2020

Thank You