Sustainable Agricultural Mechanization

9th TC of CSAM

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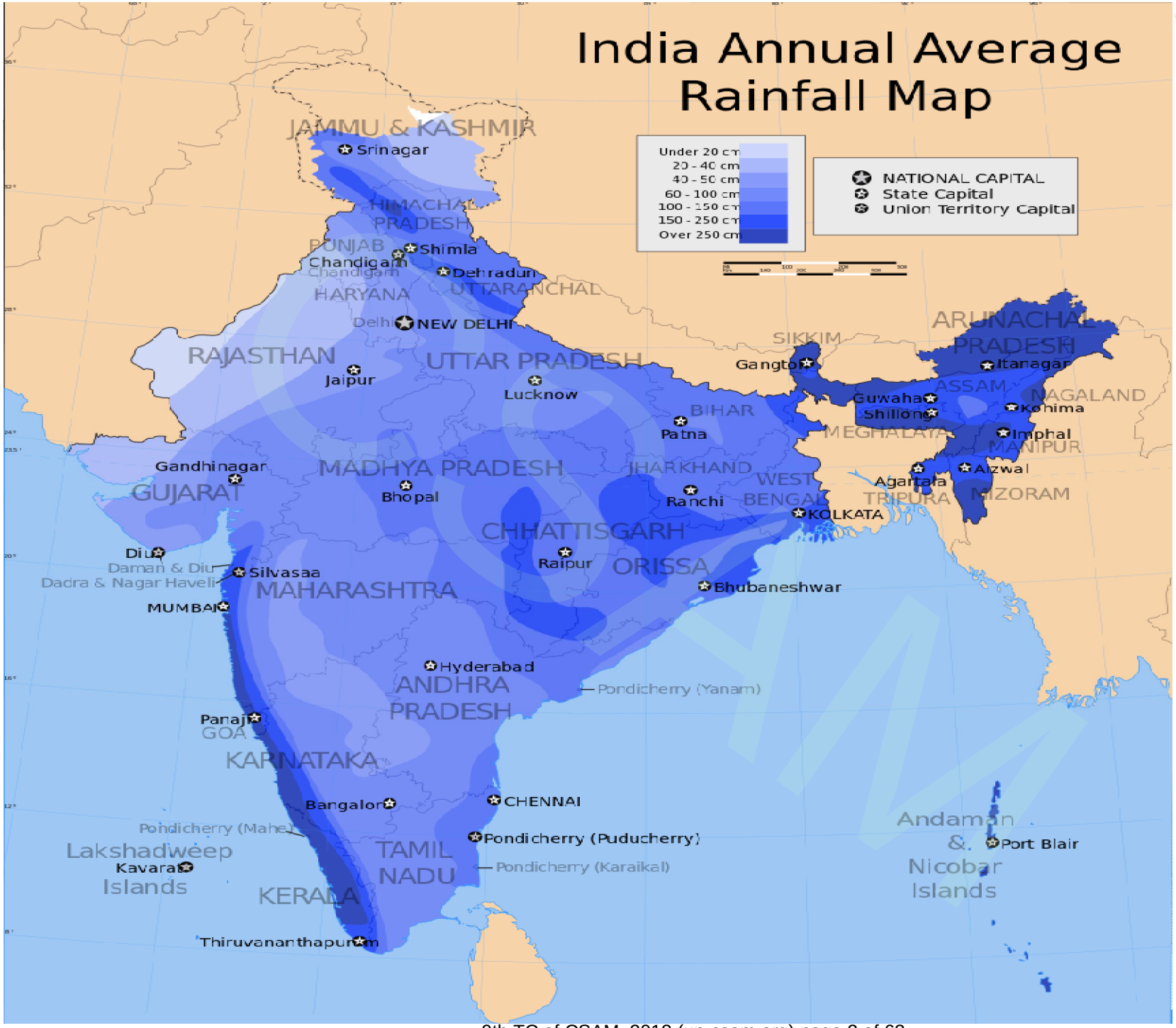
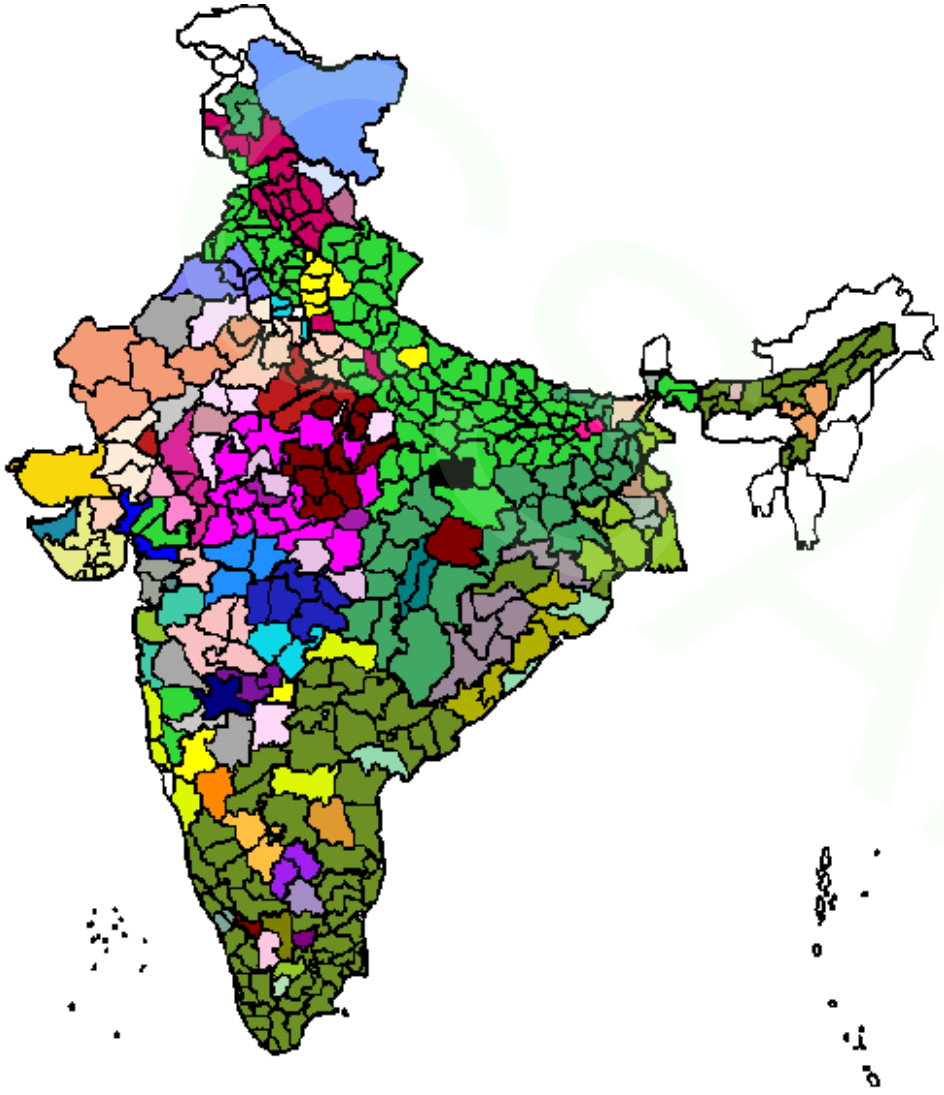

India Annual Average Rainfall Map
Under 20 cm
20 - 40 cm
40 - 50 cm
60 - 100 cm
100 - 150 cm
150 - 250 cm
Over 250 cm
NATIONAL CAPITAL
State Capital
Union Territory Capital
JAMMU & KASHMIR
Srinagar
HIMACHAL PRADESH
PUNJAB
Shimla
Chandigarh
Dehradun
UTTARANCHAL
HARYANA
Delhi
NEW DELHI
RAJASTHAN
Jaipur
UTTAR PRADESH
Lucknow
SIKKIM
Gangtok
ARUNACHAL PRADESH
Itanagar
ASSAM
Guwahati
Shillong
NAGALAND
Kohima
BIHAR
Patna
MEGHALAYA
Imphal
MANIPUR
Aizwal
MIZORAM
Agartala
TRIPURA
JHARKHAND
Ranchi
WEST BENGAL
KOLKATA
Gandhinagar
GUJARAT
MADHYA PRADESH
Bhopal
CHHATTISGARH
Raipur
ORISSA
Bhubaneshwar
Diu
Daman & Diu
Dadra & Nagar Haveli
Silvasaa
MAHARASHTRA
MUMBAI
Hyderabad
ANDHRA PRADESH
Pondicherry (Yanam)
Panaji
GOA
KARNATAKA
Bangalore
CHENNAI
Pondicherry (Mahe)
Pondicherry (Puducherry)
Lakshadweep
Kavaratti
Islands
TAMIL NADU
Pondicherry (Karaikal)
KERALA
Thiruvananthapuram
Andaman & Nicobar Islands
Port Blair

Major Cropping Systems in India



- Rice – wheat (10.5 m ha)
- Rice – rice (5.89 m ha)
- Cotton – wheat (1.09 m ha)
- Soybean – wheat (2.23 m ha)
- Maize – wheat (1.86 m ha)
- P. millet - wheat (2.26 m ha)

Indian Agriculture

- Net sown area: 140 million ha (42.6%)
- Agricultural workers - 263 million
- Employs about 55% of the work force
- Provides livelihood to about 60% of the population
- Contributes 14% to the Gross Domestic Product (GDP)
- Yearly production
  - Food grains – 259 million tonne (2012-13)
  - Fruits – 76 million tonne (2011-12)
  - Vegetables - 156 million tonne (2011-12)
- No. of land holdings – 138 million

Indian Agriculture

- Small fragmented land holdings, hill agriculture and shifting cultivation
- 15% farms are semi-medium (2-4 ha), medium (4-10 ha) and large (more than 10 ha) sizes
- 85% are small and marginal (< 2 ha)

Approach to mechanization of Indian agriculture

- Improved equipment and
- Enhanced farm power supply

Maintain a socially desirable mix of human labour, draught animal power and mechanical power

Challenges

- India accounts for 2% of World's geographical area and 4% of water resources
- But, it supports 17% of total human population and 15% of livestock
- Shrinkage of farm holding

Å Scarcity of farm worker in peak seasons due to MGNREGA.

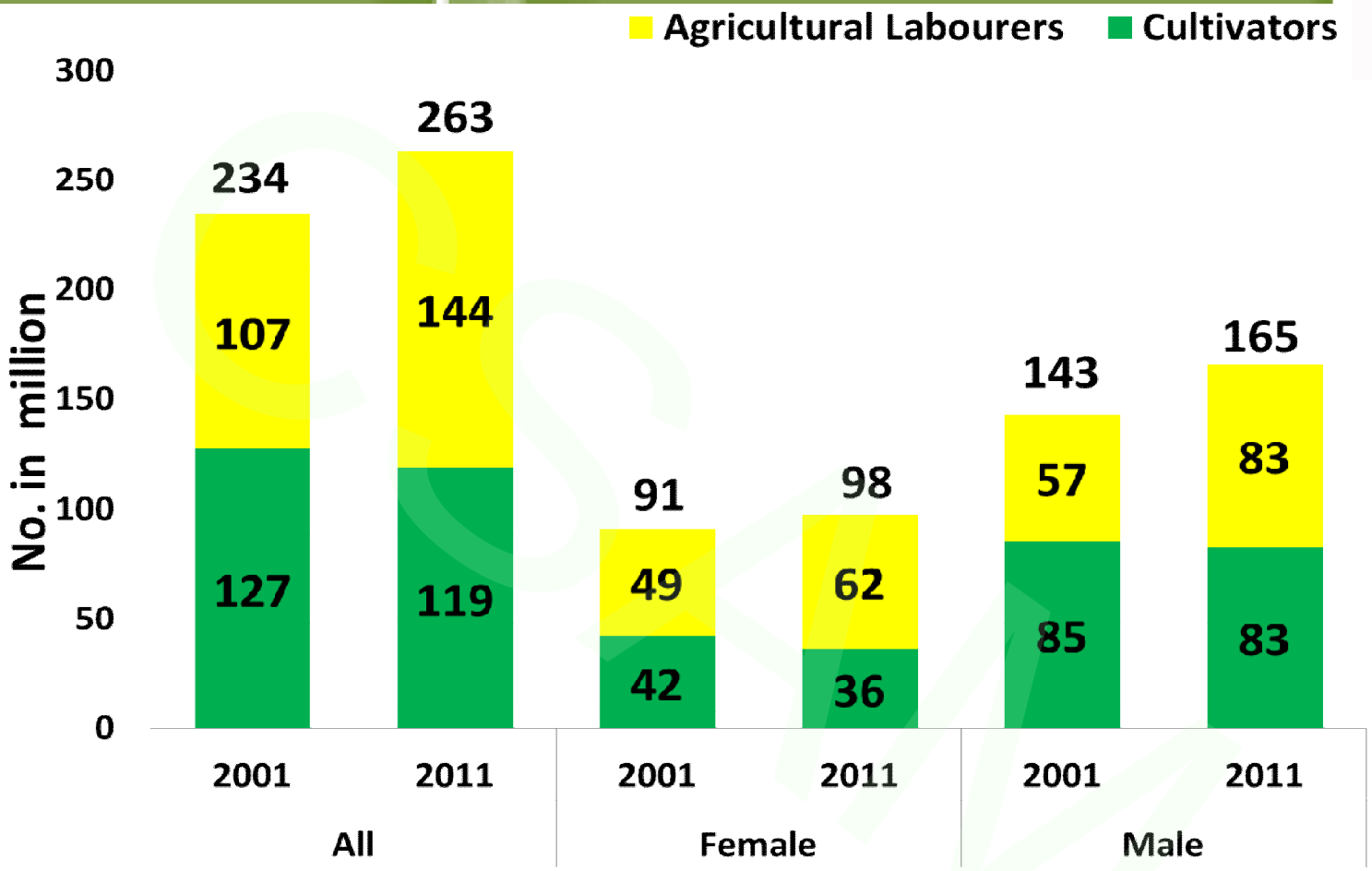
- The challenges in 21st century:
  - Food, nutritional and livelihood security
  - Reducing rural poverty through inclusive growth of farm mechanization
  - Reduce or reverse natural resource degradation, especially land

These challenges needs to be resolved in the face of uncertainties of 'Climate Change'.

Population Dynamics of Indian Agricultural Workers (No. in million)

Particulars	2001	2011	2020
Countryôs population	1029	1211	1323
No. of workers as % of population	39	39.8	42.8
Total no. of workers	402	482	566
% of agricultural workers to total workers	**58.2**	**54.6**	**40.6**
No. of agricultural workers	234	263	230
% of females in agril. work force	**39**	**37.2**	**45.0**
No. of male agricultural workers	143	165.7	126.5
No. of female agricultural workers	91	97.31	103.5

Cultivators reduced by 7%, Agril. labourers increased by 35%



Number of Agricultural workers

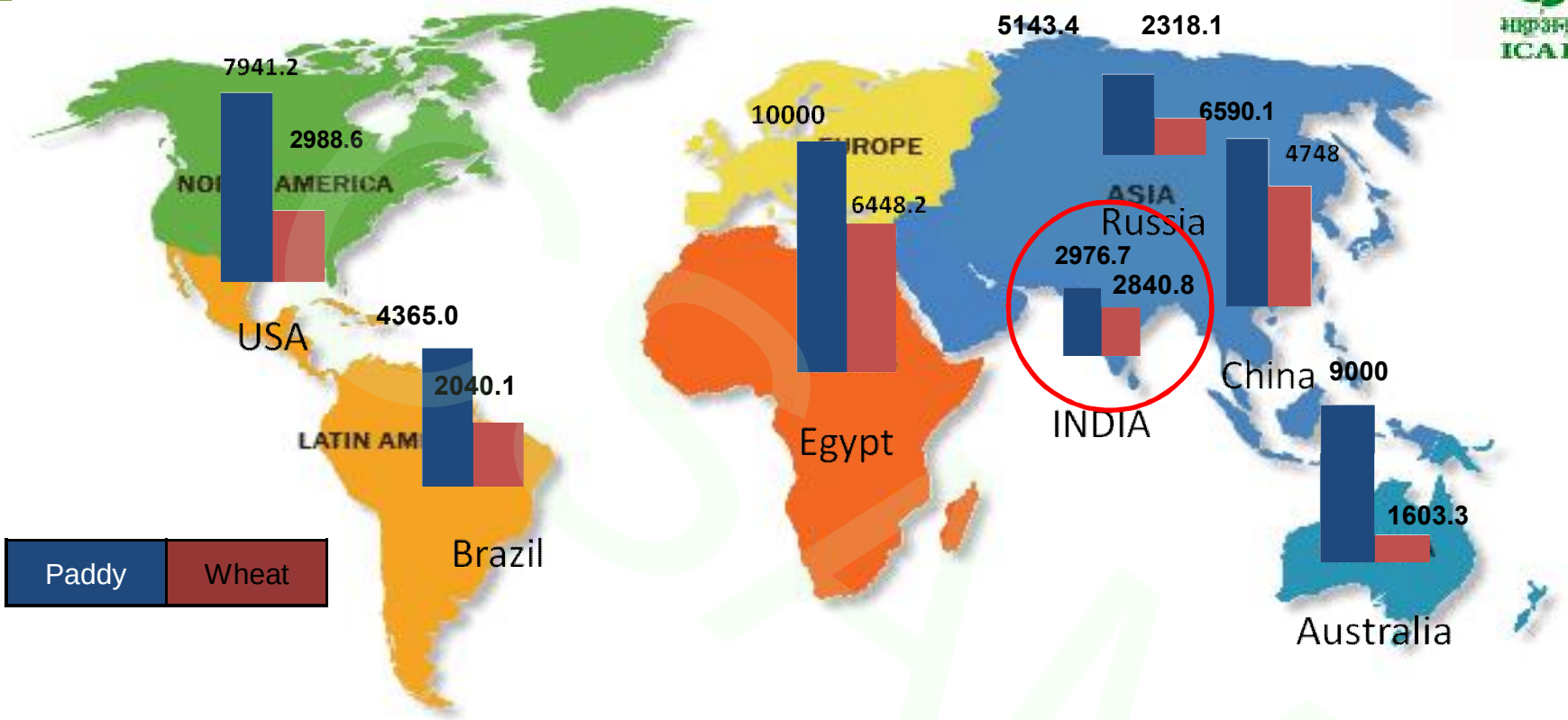
Male agril. labourers increased by 46%

Female agril. labourers increased by 27%

Global Ranking of India in Farm Production and Productivity

Crop	Production Rank	Production in 2011 (million t)	Productivity Rank
Paddy	2nd	157.90	30th
Wheat	2nd	86.87	22nd
Maize	6th	21.76	35th
Groundnut	2nd	6.96	40th
Rapeseeds	3rd	8.18	28th
Pulses	1st	0.70	44th
Soybean	5th	12.21	44th
Potato	2th	42.34	26th
Sugarcane	2nd	342.38	9th
Fruits	2nd	76.40	-
Vegetables	2nd	155.90	-

Crop Scenario

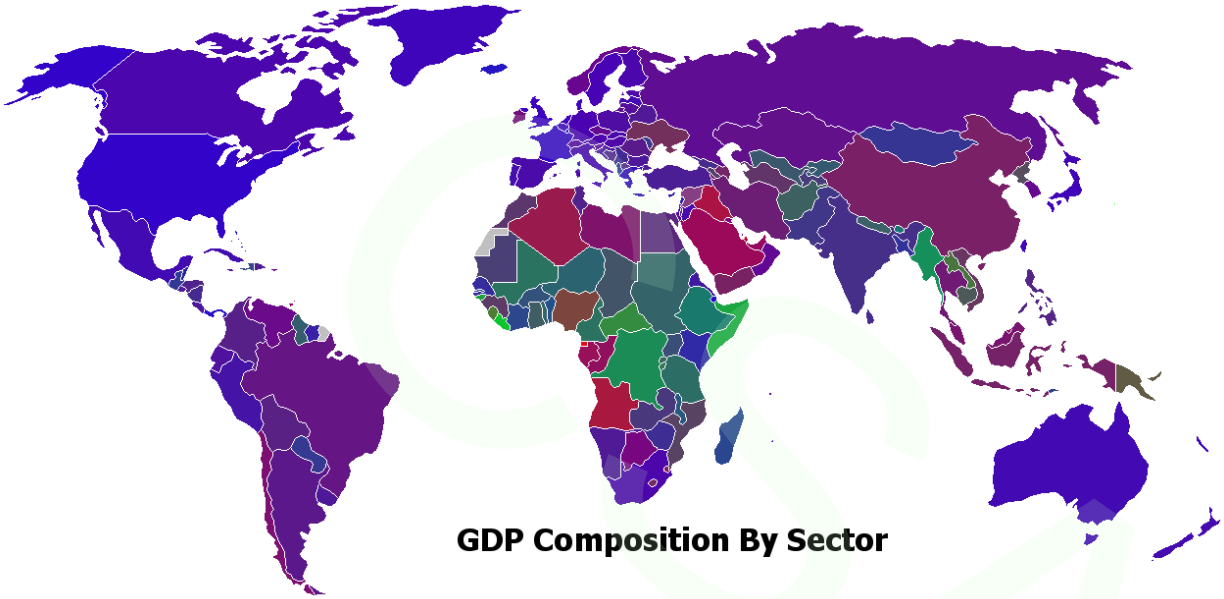


India very low on Productivity

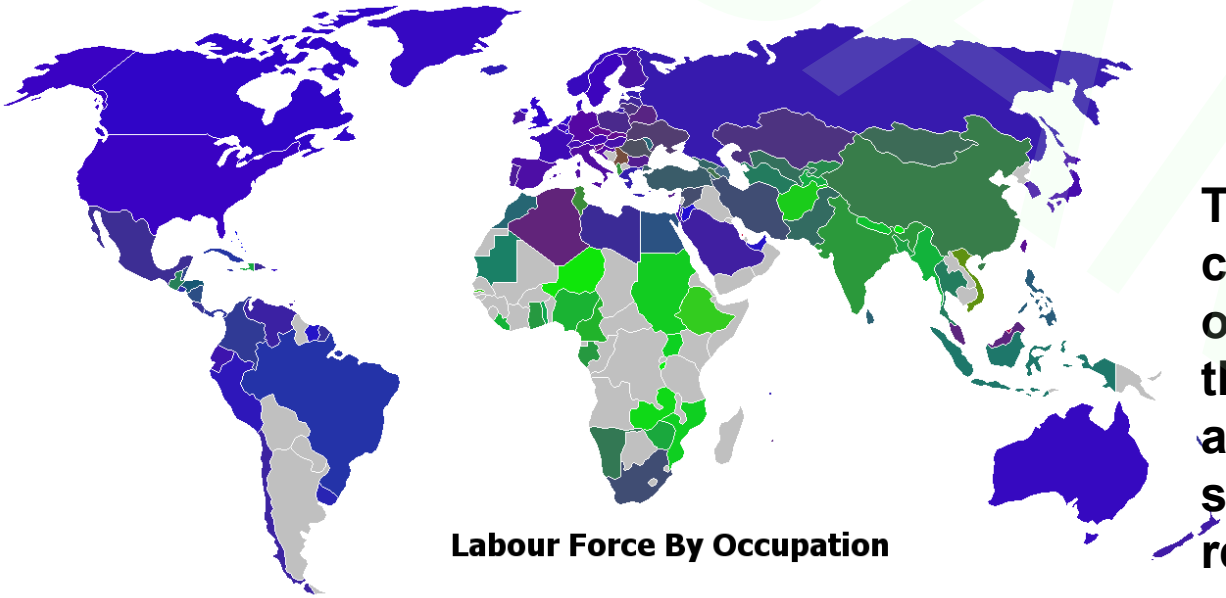
Yield of principal crops in developed nations is much higher than other developing nations, one of the reason being less adoption of automation

** Figures represents Yield of major crops during 2009*
*** Yield is defined as kg/ha*
Source: FAOSTAT

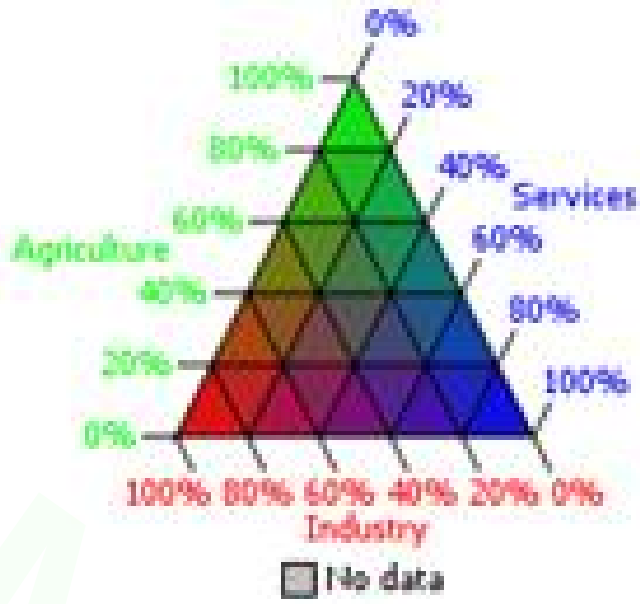
Mechanization - Precursor of Development



GDP Composition By Sector

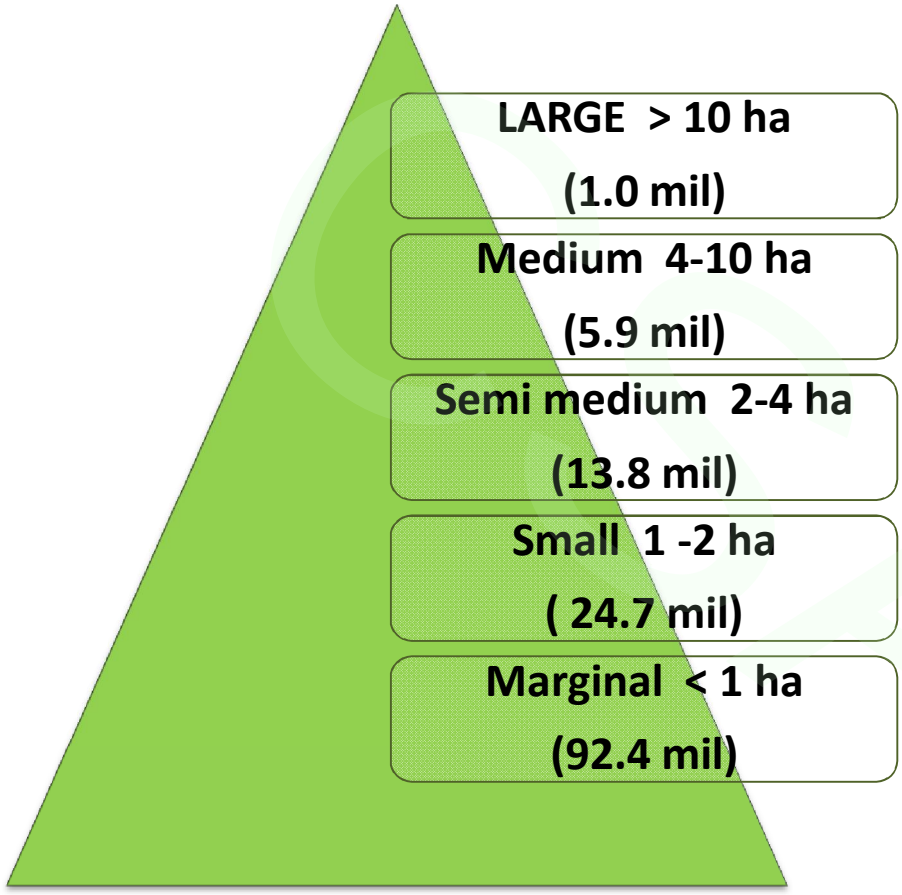


Labour Force By Occupation



The green, red, and blue components of the colours of the countries represent the percentages for the agriculture, industry, and services sectors, respectively.

Indian Agriculture



Average land holding and no. of farmers

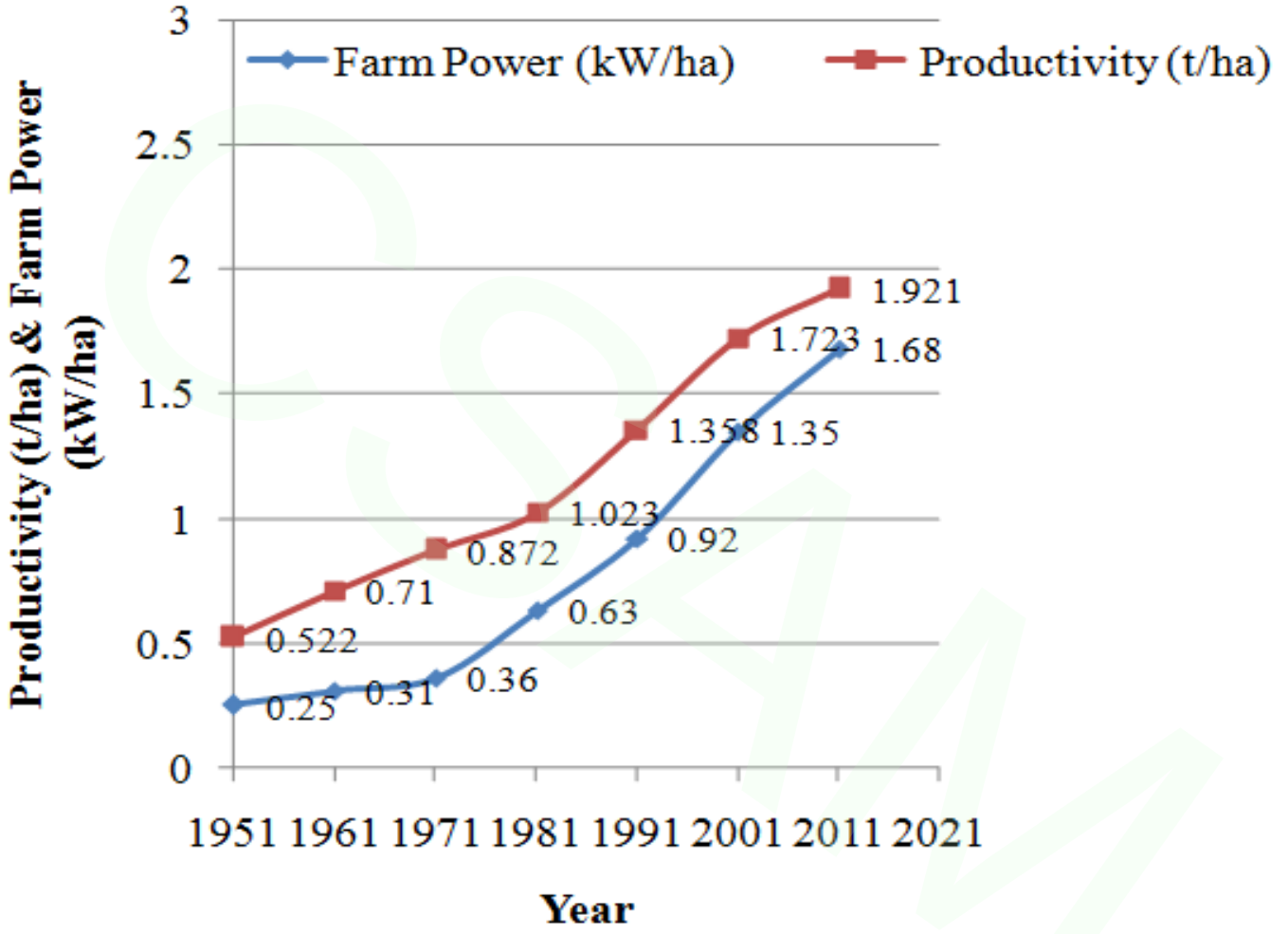
- **Highest arable land -** 47% of total land against Avg. 11% in the world
- **Round the year cultivation -** 20 Agro-climatic regions and 46 soil types suited for round the year cultivation
- **Ranks first** in production of Pulses, Sorghum, Jute and allied fibers
- **Second largest producer** of Wheat, Rice, Groundnut, Tea, Fruits and Vegetables, Sugarcane
- **Third largest producer** of Mustard, Potatoes, Cotton lint, etc.
- **137.8 million cultivators,** over 5.0% own > 4 ha. Avg farm land size <2 ha,

Bottom of Pyramid Country; Affordability, Equipment size are key to success. Emerging - Cooperative ownership model/custom hiring, use of high end equipment

Cropping Intensity, Power Availability on Indian Farms

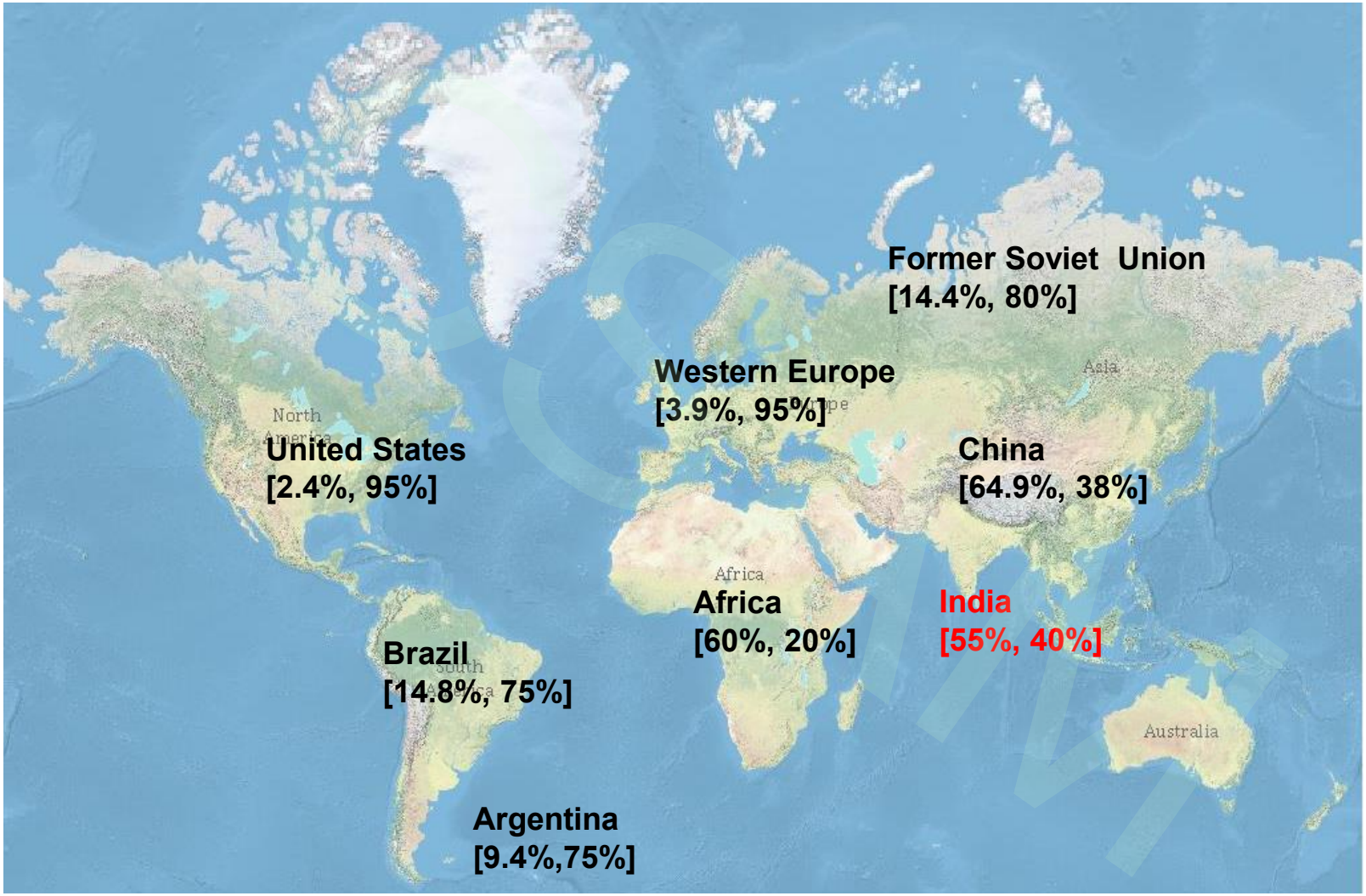
Year	Cropping intensity (%)	Productivity (t/ha)	Power available (kW/ha)	Power per unit production (kW/t)	Net sown area per tractor (ha)
1975-76	120	0.94	0.48	0.51	487
1985-86	127	1.18	0.73	0.62	174
1995-96	131	1.50	1.05	0.70	84
2005-06	135	1.65	1.47	0.89	47
2010-11	137	1.92	1.68	0.88	31

Farm Power Availability and Productivity of Food Grains in India (1951-2011)



Agricultural productivity has a positive correlation with farm power availability

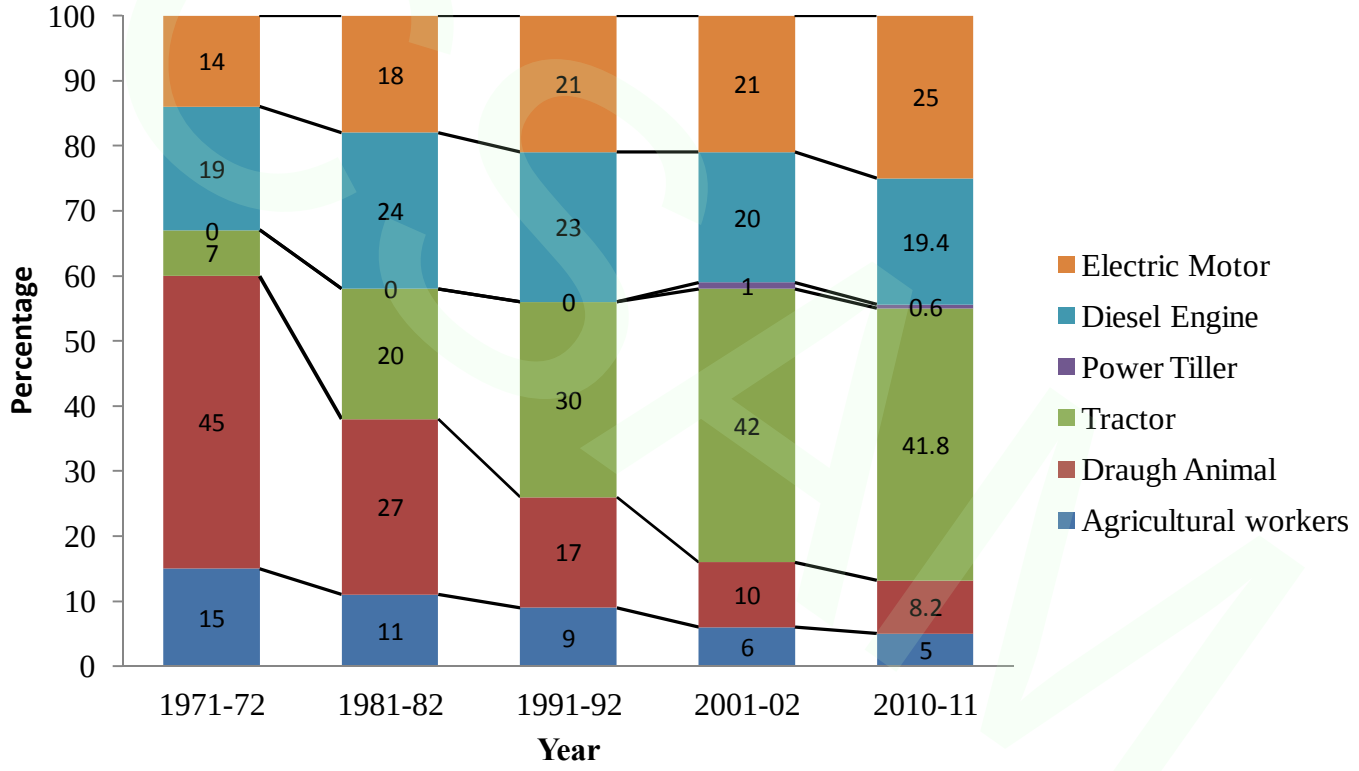
Population Engaged in Agriculture Vis-a-vis Level of Farm Mechanization



Higher share of labour (55%) with lesser contribution to farm mechanisation (40%) in India makes farming less remunerative and leads to farmers' poverty

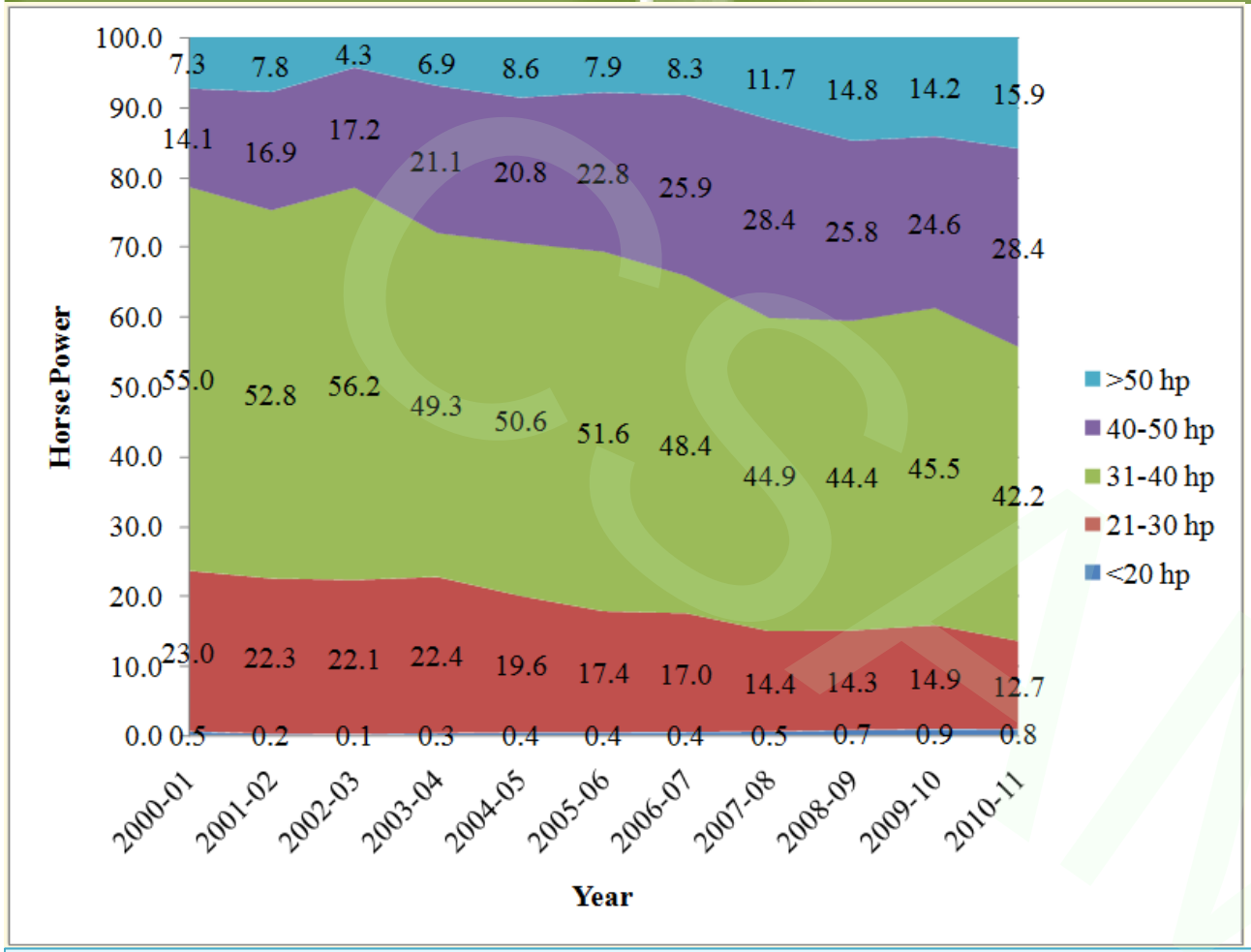
Power Availability Trend….

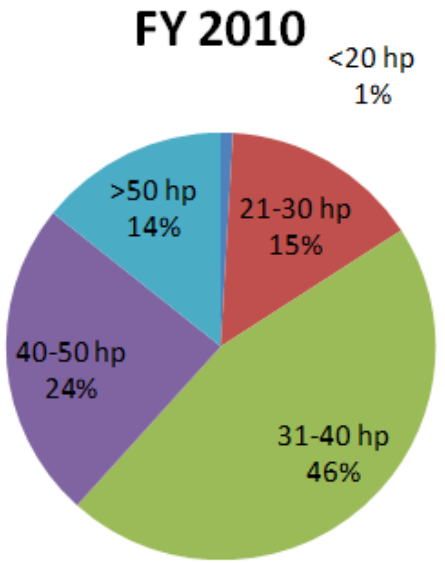
The changing face of technology is leading to increase in mechanisation and this trend is expected to continue in near future

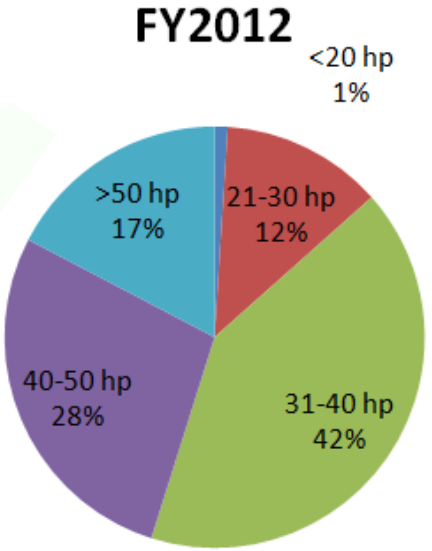


Share of agricultural worker & draught animals came down from 60.5% in 1971-72 to 13.2% in 2010-11

Power-wise Trend in Sale of Tractors in India

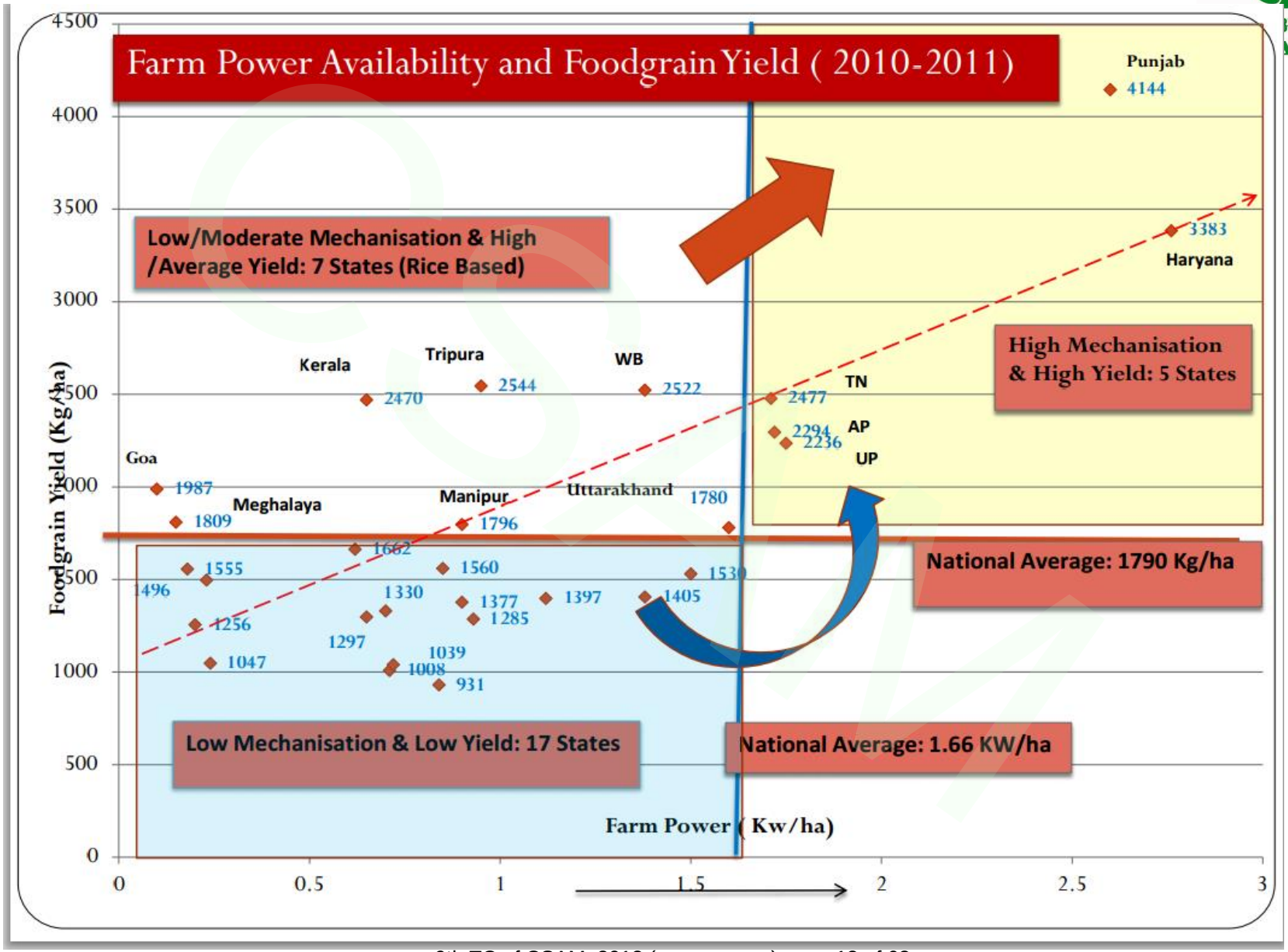






Huge opportunity at entry level, virgin sub 15 hp segment replacing bullock

Sales to witness polarization towards high- and low-power segments

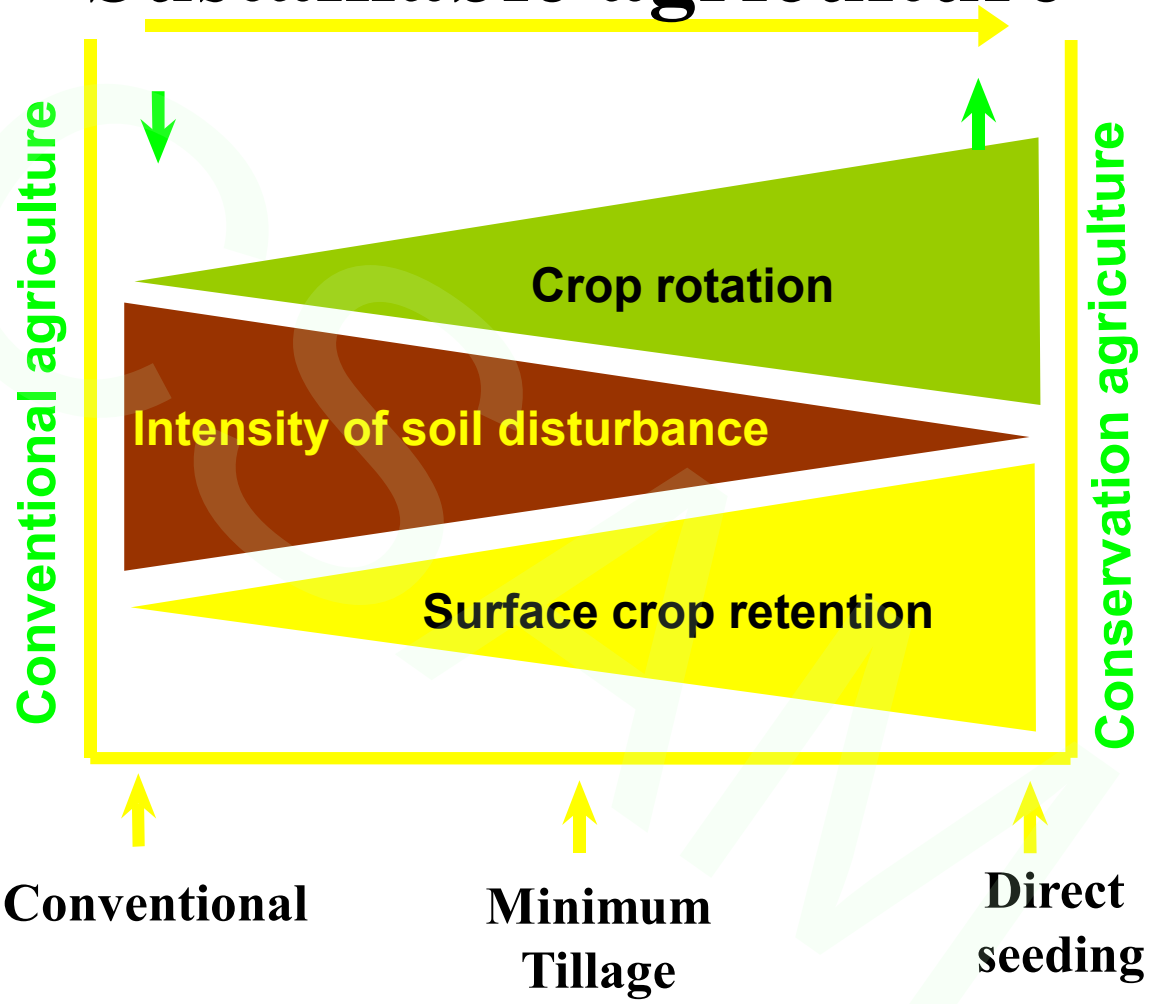

Farm Power Availability and Foodgrain Yield (2010-2011)
Foodgrain Yield (Kg/ha)
Farm Power (Kw/ha)
Low/Moderate Mechanisation & High /Average Yield: 7 States (Rice Based)
High Mechanisation & High Yield: 5 States
Low Mechanisation & Low Yield: 17 States
National Average: 1790 Kg/ha
National Average: 1.66 KW/ha
Punjab 4144
Haryana 3383
TN 2477
AP 2294
UP 2236
Kerala 2470
Tripura 2544
WB 2522
Goa 1987
Meghalaya 1809
Manipur 1796
Uttarakhand 1780
1662
1555
1496
1560
1530
1330
1377
1397
1405
1285
1256
1297
1039
1047
1008
931
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
0.5
1
1.5
2
2.5
3

Level of Farm Mechanization in India

Operations	Percentage
Soil working and seed bed preparations	42
Seeding and planting	29
Plant protection	34
Irrigation	37
Harvesting and threshing	60-70% for wheat and rice and < 5% other crops

Overall about 40-45 %

Sustainable agriculture



Conservation Agriculture

- **Minimum or no soil disturbance (Zero tillage, No-tillage)**
- **Permanent soil cover (residues or green manure cover crops (GMCCs)**
- **Crop rotation**
- **Integrated disease and pest management**
- **No burning**

Tractor drawn laser land leveller

Used for micro levelling of field and pulling loose soil from one place to other

Performance evaluation of laser guided land leveler

S. No	Variables	Values
1.	Forward speed, km/h	4.0-6.0
2.	Field capacity, ha/h	0.10-0.20
3.	Standard deviation of reduced level after leveling, cm	0.55-0.90
4.	Leveling index, cm	0.44-0.63
5.	Volume of soil tilled, m^3	50-90
6.	Cost of leveling, Rs./ha	1670-3000

Machinery for Manure Application

Animal drawn manure spreader

- Developed at SHIATS, Allahabad and CIAE Bhopal
- Hopper capacity: 3.75-4.00 q
- Width of operation: 1.1 to 1.2 m
- Application rate: 4-18 t/ha
- Field capacity: 0.18-0.20 ha/h

Tractor operated farm yard manure spreader

Capacity : 2 tonne

Field capacity: 0.38 ha/h at 2.5 km/h

Type of spreading unit: A cylinder of 40 mm diameter having 12 numbers of beaters on periphery.

Tractor-operated Rotavator

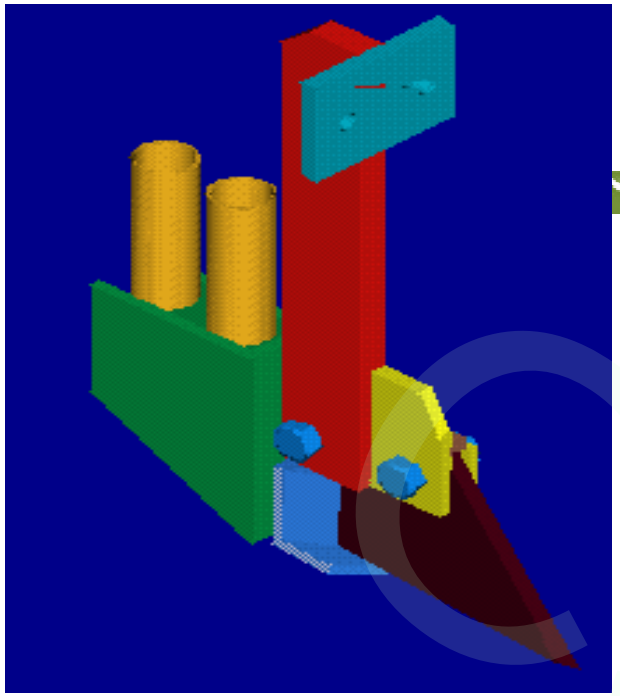
- Prepares dry seed bed in one operation and in heavy soils in two operations. It mixes crop residue and weeds in soil effectively.
- Field capacity: 0.25–0.40 ha/h
- The machine saves about 40-60% of time and 25-40% of fuel consumption as compared to the conventional tillage implements.
- Field condition after rotavator operation

Plastic Mulch Laying Machine

It has great potential for adoption in vegetable cultivation

Field capacity: 0.23 ha/h

Efficiency of plastic laying machine: 75%



Inverted ‘T’ furrow opener for Zero till-drill

Energy & moisture conservation

Saving in time : 40-70%

Saving in fuel : 64%

Saving in water:10-15 %

Zero till-drill in operation

(5 million ha area)

CAM Developed in India




Machine parameters	Zero till drill	Strip till drill	Roto till drill	Slit till drill	Conventional (3 Tillage + Sowing)
Working width, mm	1600-2000	1800	2000	1800	1850
Weight, kg	210	350	350	300	-
Unit price, Rs.	30000	60000	70000	55000	20000 + 25000
Time, h/ha	3.23 (70.1)	4.17 (61.2)	3.45 (68.1)	2.50 (76.8)	10.80
Fuel used, l/ha	11.50 (66.8)	17.50 (49.4)	14.80 (57.2)	10.00 (71.1)	34.60
Operational energy, MJ/ha	650 (67.2)	1002 (49.3)	784 (60.3)	565 (71.4)	1976

CAM: Economic impact




Particular (s)	Zero till seeding	Strip till seeding	Roto till seeding	Slit till seeding	Conventional (3 Tillage + Sowing)
Cost of operation, Rs./ha	1400 (58.8)	2000 (41.2)	1800 (47.1)	1000 (70.6)	3400
Saving, Rs./ha	2000	1400	1600	2400	-
Command area, ha	45	30	40	50	-
Benefits, Rs./year	90000	42000	64000	120000	-
No. of units	25000	500	2000	05	-
Annual benefits, Rs., million	2250	21	128	0.6	-

Tractor operated Raised bed planter

inclined plate type

Field capacity - 0.2 ha/h
Saves - 20-30% water through furrow irrigation

Suitable for sowing of wheat, winter maize and other crops on ridges.

Tractor operated Raised bed planter

inclined plate type

Wheat

Crops sown on raised bed

Groundnut

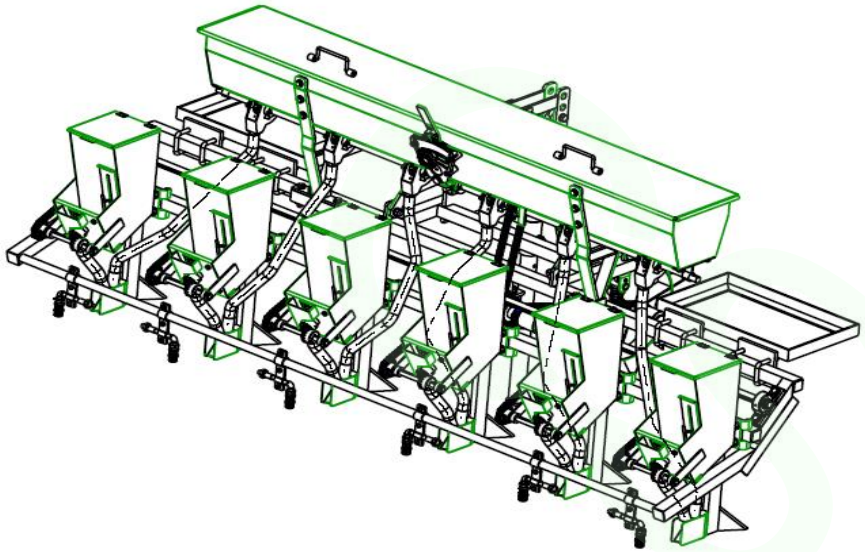
Ladyôs finger

Bed planting on fresh and permanent beds



Particular	Planting on fresh beds with tillage	Planting on permanent beds	Flat sowing zero tillage	Conv. Flat sowing
Time required, h/ha	13.0	5.0	3.2	10.8
Operational energy, MJ/ha	2605	1154	650	1976
Cost of operation, Rs./ha	4300	1750	1400	3400
Savings over conv. practice, Rs./ha	-	1650	2000	-
Command area, ha	-	30	45	-
Annual benefit, Rs./ha	-	49500	90000	-
No. of units	-	500	25000	-
Annual benefits, Rs., million	-	25	225	-

Pre-emergence herbicide strip applicator



Rice Transplanting

Traditional Method

- The worker has to insert her fingers in mud about 0.17 million times per ha. It causes skin problem to fingers/hand.
- Involves a lot of drudgery due to operation in bending posture.
- Output - 40 m^2/h

4-Row Rice Transplanter

Field capacity	: 135 m^2/h
Cost	: Rs. 10000/-
Power source	: 1 person
Operating speed	: 0.5 km/h

Bending is avoided

Lowland Paddy Seeder

AICRP on Farm Implements and Machinery

Results in saving of seed, labour and water

Field capacity	: 0.06 - 0.12 ha/h
Cost of the unit	: Rs. 4000 - 5700/-
Cost of operation	: Rs. 450 per ha
Seed rate	: 50 kg/ha
Row spacing	: 200 mm (8 row)

Tractor Mounted Rice Seeder (TNAU)

- **Field capacity : 0.65 ha/h**
- **Cost of the unit : Rs. 30,000/- (attachment)**
- **Cost of operation : Rs. 400/ha**
- **Saving in labour and time : 72%**

SRI Planting
Manual Method

SRI Self-propelled Transplanter (TNAU)

Self-propelled reaper binder

Cuts the crop and makes the bundle of about 5 kg and drops in the field.

- ✓ **Field capacity = 1.5-2.0 ha/day**
- ✓ **Grain losses = 2-5% for wheat**
  1-5% for paddy

High capacity multi-crop thresher

- Used for threshing of cereals, pulses & oil seeds crops.

- **The grain output capacity**
  - **Wheat - 16-20 q/h**
  - **Raya - 8-10 q/h**
  - **Gram - 6-8 q/h**
  - **Green gram - 4-5 q/h**
- **Threshing efficiency - 98-99%,**

Self-propelled Rice Combine (CLASS)

Field capacity: 4 ha/day

Cost : Rs. 16.00 lakh

Tractor Mounted Combines

Field capacity: 4 ha/day

Cost: Rs. 12.50-14.00 lakh

Tractor operated straw reaper (combine)

AICRP on Farm Implements and Machinery

Tractor operated straw reaper with trailer

Field capacity : 0.4 ha/h
Cost: Rs. 3.25 lakh

Hay rake in operation to collect paddy straw

Straw baler being used to make bales of paddy straw

Bio-fuels and renewable energy

- Contribution of the Renewable energy to Farm power availability is 1443 MW i.e. 0.7%
- Renewable Energy technologies like solar, biomass, hydro, etc are deployed both in rural and urban areas to curb the growing gap between the demand and supply of power.
- A target to harness 20000 MW of solar energy by 2022 has been set up under Prime Minister Solar Energy Mission
- Indian clean development mechanism projects cover a range of sectors viz power generation from renewable energy, particularly wind and hydro power, biomass applications, waste heat and energy recycling.

Large Capacity Fixed Dome Type Biogas Plants

Capacity:
10 to 110 m^3 gas/day

Digester & gas dome - made of brick masonry

Water requirement - reduced by up to 70%

Cost of plant - 50% less than KVIC

110 m^3 fixed dome biogas plant at a farmer's site at village Malsian (Distt. Jalandhar)

Plants set-up in Punjab, Raj., MP, MS, Karnataka & Goa

Walk-in-type Solar Tunnel Dryer for Agro-industrial Applications

Surgical cotton drying at M/s Raj Surgical, Udaipur

Three units each of 3.75 m x 19 m (1800 kg cotton/batch)

MC 40% → 5% (one day), Investment: Rs. 3.30 lakh

Economic benefit – Rs. 172250/unit/year over conventional system

These dryers are also used for drying of coconut splits, gooseberry, grapes, chillies, stevia leaves etc.

Forced Circulation Solar Dryer

Forced circulation solar dryer equipped with composite SAHs installed in a Gujarat State Forest Development Corporation's Unit at Vadodara Unglazed flat plate type – Rs. 3,000/m^2 area

Packed bed type SAH panels installed on the roof of M/s Raghav Wollen Mills, Ludhiana

Cost of packed bed type – Rs. 4,500/m^2 area

Efficiency of the packed bed type SAH is 40% more as compared to sun drying

Solar Refrigerator for Rural Applications

Solar Refrigerator installed in a veterinary clinic near Anand

Solar Refrigerator installed at Veterinary laboratory of CSKHPKVV Palampur

SPRERI SPV refrigerator 80 l capacity, top opening
200 Wp panel, 24 V, 130 Ah, Cost: Rs. 1,20,000/-
20 units are in use in Veterinary Centres
Manufacturer: M/s Mamta Industries, Ahmedabad

Electricity from Solar Energy for Rural Applications

Street lighting

Irrigation water pumping

PV module - 74 W_p

CFL - 11 W

Lead acid battery - 12 V, 75 AH

PV module – 200-3000 W_p

Pump of matching capacity

Cost: Rs. 150000/- (900 W_p)

Cost of SPV panel – Rs. 125 –150/W, Cost of electricity – Rs. 15-20/kWh

Bio-diesel Plant (TNAU design)

Bio-diesel plant - 250 l/day, Yield - 75-90%

Biomass gasifier based power generation system

National Initiative on Climate Resilient Agriculture (NICRA)

- Network project of the ICAR launched in February, 2011 with CRIDA, Hyderabad as the lead centre.
- The project aims to enhance resilience of Indian agriculture to climate change and climate variability through strategic research and technology demonstration.
- Central Institute of Agricultural Engineering (CIAE), Bhopal is one of the core institute giving major thrust on Engineering interventions for conservation agriculture, precision farming and energy use efficiency.

Testing Network in India

1. CFMT&TI, Budni, M.P.
2. NRFMT&TI, Hisar, Haryana
3. SRFMT&TI, Garladinne, A.P.
4. NERFMT&TI, Biswanath Chariali, Assam

Other Institutions for Testing Agricultural Machinery in India (28)

SAUs	:	21
ICAR Institutes	:	2
IIT	:	1
State Govt. Institute	:	4

Policy Mandate

- **Requirement for Farm Mechanization**
  - Farm power requirement by 2020 - 2.5 kW/ha
  - Removal of regional disparities
- **Infrastructural and Institutional Framework**
  - Adequate engineering infrastructure at implementation level
  - Effective training and extension service
  - Repair and maintenance facilities
  - Machinery banks for custom hiring services
  - Credit at simple terms
- **Appropriate Farm Machines and Equipment**
  - For small and marginal land holdings
  - Crop specific quality machines
  - For hill agriculture
  - Gender specific

Policy Initiatives by the Government of India to Promote Farm Mechanization

- Training
  - Establishment of four Farm Machinery Training and Testing Institutes (FMTTI)
- Demonstration
  - Large scale demonstration of equipment at farmers field
- Incentives for Purchase of Equipment
  - Subsidy through MMA, NFSM, NHM and similar other schemes available to all categories of farmers
  - Incentives for establishment of Machinery Banks at block levels for custom hiring services
- Identification of Machines
  - Hill agriculture
  - Gender friendly tools and equipment
  - Crop specific package of machines

Policy Initiatives by the Government of India to Promote Farm Mechanization

- **Manufacturing Sector**
  - De-reservation of manufacturing of agricultural machines from small scale sector
  - Training on manufacturing technologies
- **Quality of Machines**
  - Minimum performance standards for tractors, power tillers and combine harvesters framed
  - Standard specifications for all machines
  - Equipment promotion through subsidy: Testing by FMTTI or BIS certification is mandatory
- **Credit**
  - NABARD refinance available and financing norms simplified
- **Agro Processing Sector**
  - Scheme on post harvest technology
  - Technologies developed by ICAR/CSIR promoted

National Mission on Farm Mechanization

- **Increasing the reach of farm mechanization to small and marginal farmers and to the regions where availability of farm power is low**
- **Offsetting adverse 'economies of scale' and 'higher cost of ownership' of high value farm equipment by promoting 'Custom Hiring Centre' for agricultural machinery**
- **Passing the benefit of hi-tech, high value and hi-productive agricultural machinery to farmers through creating hubs for such farm equipment.**
- **Promoting farm mechanization by creating awareness among stakeholders through demonstration and capacity building activities**
- **Ensuring quality control of newly developed agricultural machinery and equipment through performance evaluation and certifying them at designated testing centers located all over the country.**

Sub-mission on Agricultural Mechanization during 12th Five Year Plan

S. No.	Components
1	Promotion & strengthening of agricultural mechanisation through training, testing and demonstration
2	Post harvest technology and management
3	Financial assistance or procurement subsidy for selected agriculture machinery and equipment
4	Establishment of farm machinery banks for custom hiring by small and marginal farmers
5	Establishing hi-tech and high productive equipment hub for custom hiring
6	Enhancing farm productivity at village level by introducing appropriate farm mechanization in selected villages
7	Creating ownership of appropriate farm equipment among small and marginal farmers in the eastern/north eastern regions

Individual Ownership OR Custom Hiring

Key Question is How to cater marginal and small farmers who aggregate to > 80% of cultivators

Conclusions

- Future farm mechanization through mechanical sources of power
- R&D in farm mechanization through Public Private Partnership mode
- Equipment/technology for increasing input use efficiency
- Machines suitable for custom hiring – high capacity, high labour productivity
- Quality manufacturing and after sales support for reliability of farm machinery.

Conclusions

- Mechanization of horticulture and hill agriculture
- Mechanization of sugarcane harvesting and cotton picking
- Centralized nursery raising for horticultural crops and rice
- Covered cultivation
- Adoption of conservation agriculture and precision farming
- Consideration of ergonomics and safety in farm equipment/machinery design
- Contract farming
- Farm machinery bank

Thank You

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