Good Practices and Successful Cases of Conservation Agriculture and Conservation Agriculture Mechanization

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Regional Workshop on the Role of Mechanization in Strengthening Smallholders' Resilience through Conservation Agriculture in Asia and the Pacific
18-20 April 2018, Phnom Penh, Cambodia

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Indian Agriculture

7th largest country in terms of area
29 states

- **Net sown area - 140 million ha (42.6%)**
- **Agricultural workers - 263 million**
- **Employs about 52% of the work force**
- **Provides livelihood to about 61% of the population**
- **Contributes 13% to the Gross Domestic Product (GDP)**
- **Yearly production**
  - **Produce – 283.5 million tonne**
- **No. of land holdings – 138 million**
- **15% farms are semi-medium (2-4 ha), medium (4-10 ha) and large (more than 10 ha) size**

India / South Asia: The Region With Challenges

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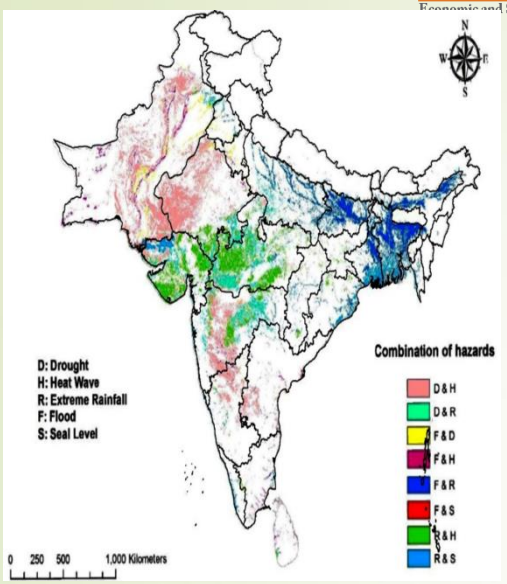

- Most populous region *yet labour availability in farming is major challenge*
- Natural resources are stressed
- A hot-spot for multiple climatic risks

MAJOR CHALLANGES

Food requirement to meet growing population (1.3 billion) without environmental degradation.

India

- **Occupies : 2.2 % of world's area**
- **Supports : 18% of world's population**

Agricultural land: 61% of total land area

- **Food Production growth : falling/stagnating**

Climate change:

Temperature and rain variability affects productivity

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ENERGY SCENARIO IN AGRICULTURE

Farm Mechanization level in India: **40-45%**

90% of the total farm power by mechanical and electrical power sources.

Farm Power Availability:

0.3 kW/ha in 1971-72

2.02 kW/ha in 20014-15.

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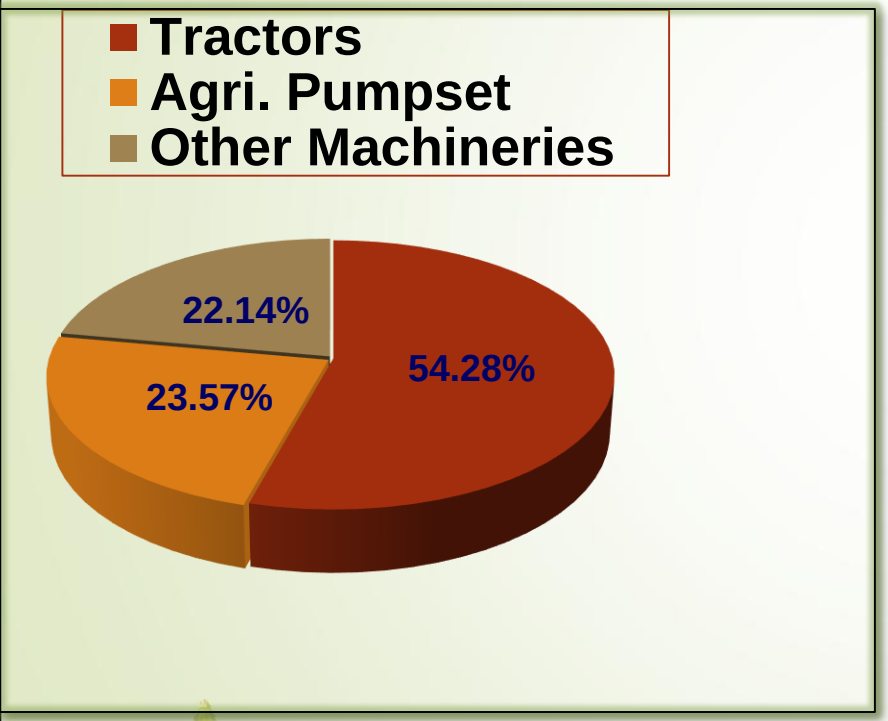
DIESEL CONSUMPTION IN AGRICULTURE SECTOR



ELECTRICITY CONSUMPTION IN AGRICULTURE SECTOR

Year	Consumption in Agril. Sector (GWh)	% Share of Total Consumption
2000-01	84729	26.76
2005-06	90292	21.92
2010-11	129051	18.16
2014-15	168913	17.81

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Measures to Save Electricity and Diesel Consumption

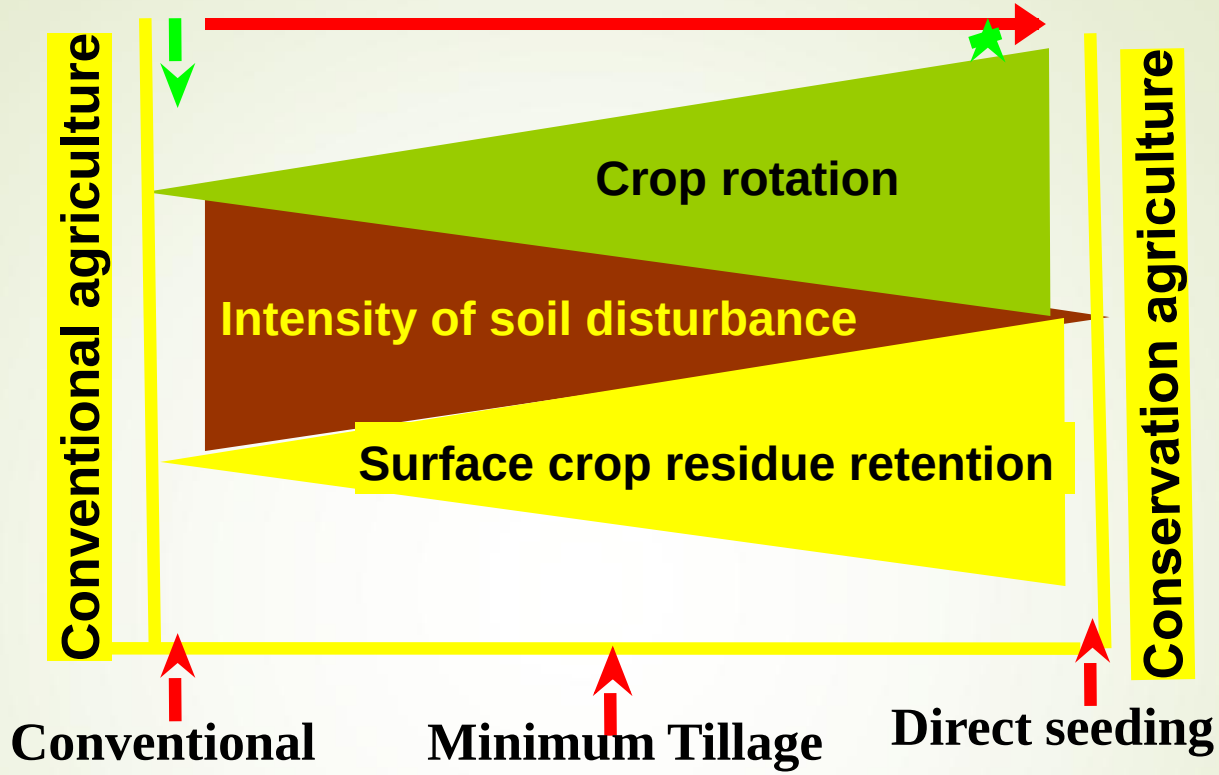
Electricity Saving **Potential**

- Design improvements in Pumps: 15-20%
- Efficient foot valves standard practices for installation of systems: 8-15%
- Solar Pumping system : 5-50%

Diesel Saving

- Matching machinery to prime mover: 20-30%
- Conservation agriculture: 20-40%
- Certified engines and pumps: 8-15%

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

Measures for reduction of energy use in agriculture

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- **Matching implements with power source**
- **CA machinery**
- **Equipment for precise application of fertilizers and chemicals**
- **Renewable energy operated machinery**
- **Reduce energy use in irrigation**
- **Real time soil moisture based irrigation system**
- **Drip irrigation system**
- **Residue management**

Matching Implements with Power Source

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- Low fuel consumption per hectare
- Higher operational efficiency
- Low operating cost

Higher Efficiency due to

- Selection of right size implements to ensure timely completion of each field operation.
- Size of tractor to be decided by the size and speeds of the implements and soil characteristics
- Types of implements to be used

LAND PREPARATION

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Minimizing energy use by

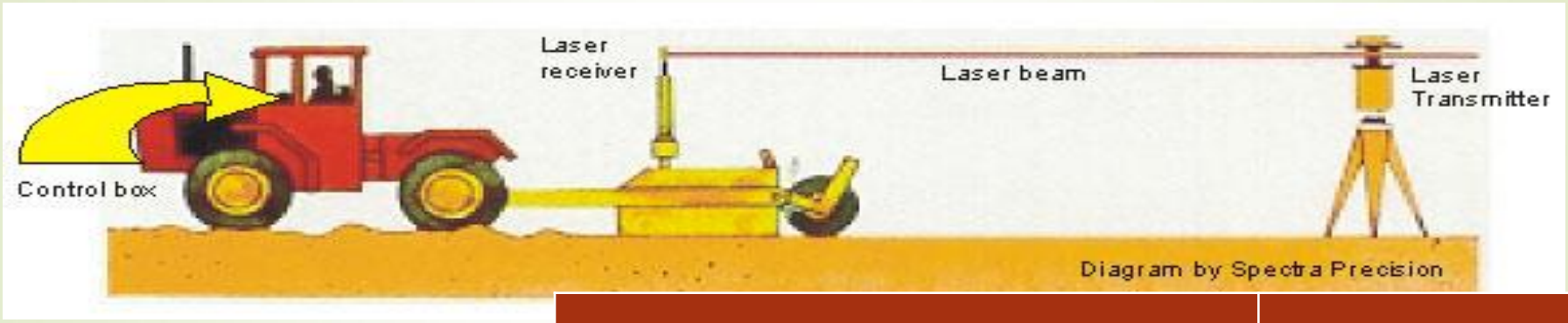
- ✓ **Minimal (reduced tillage) or**
- ✓ **Without tillage (no-till).**

We know that these practices reduces soil carbon loss with minimum soil disturbances

- **No-tillage systems also reduce energy use thus low CO_2 emissions.**
- **CA practices enhances soil carbon with retention of crop residue.**

Laser leveling?

- Laser land leveling is leveling the field within certain degree of desired slope using a guided laser beam through out the field.
- Used for micro levelling of field and pulling loose soil from one place to other



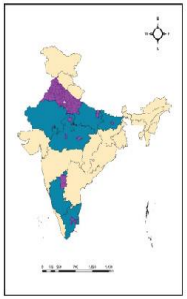
Tractor drawn laser land leveller

Forward speed, km/h	4.0-6.0
Field capacity, ha/h	0.10-0.20
Standard deviation of reduced level after leveling, cm	0.55-0.90
Leveling index, cm	0.44-0.63
Volume of soil tilled, m^3	50-90
Cost of leveling, $/ha	34-46

Movie of laser leveller

Source : M/s Dasmesh Mechanical work, India
www.landforce.in

Laser Assisted Precision Land Leveling: A Fully Validated CSAP with Impact at Scale



Introduced in India during 2000-01 (RWC/CIMMYT and ICAR-NATP)

Adoption: ~4 million ha in India

Direct employment generation: 350 person days/unit/yr

At current level (>35000 units): 10.5 million person days/yr8

Indirect employment: manufacturing, transport, services

Yield gains in RW system (3.5 mha, 0.5 t ha-1 yr-1)- 1.75 mt yr-1; ~US$ 20 million yr

Electricity saving for irrigation in RW systems of IGP (3.5 mha)- ~US$ 70 million yr-1

Water saving in RW system (3.5 mha, 18 ha-cm ha-1 yr-1) = 6.5 km3 yr-1

Other possible benefits- GHG mitigation, savings in subsidy bill etc

Case study

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SEEDING AND PLANTING

SEEDING

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HAPPY SEEDER

SEED CUM FERTILIZER DRILL

RAISED BED PLANTER

ROTO SEEDER

ZERO TILL DRILL

Movie of Happy seeder

Source : M/s Dasmesh Mechanical work, India
www.landforce.in

Residue Management (CA) using Happy Seeder

Improved soil health
(SOC 0.5 t/ha/yr)

More crop per drop
(irrigation water -40-50 ch/ha/yr)

Reduced weather risks
(Low CV in crop yield)

Lower costs and higher profits
(Profit 12000-15000/ha/yr)

Reduce chemical load
(20-25 kg N/ha, Less herbicide)

Lower GHGs emission
(~1 t CO2-eq/ha/yr)

Case study

Machinery which are able to work in residue conditions

Turbo Happy Seeder new light-weight machine named the "Turbo Happy Seeder" is now commercially available and manufacturers in India are already manufacturing this machine .

- **Turbo Happy Seeder cuts and manages the standing stubble (under straw density>5 tonnes per ha) and loose straw in front of the furrow openers,**
- **Retaining it as surface mulch and sows wheat in a single operational pass of the field.**
- **Operational costs for sowing wheat are 50-60% lower with HS than with conventional sowing**

Mini Happy Seeder

- **A mini happy seeder of 0.9 m width for two wheel tractor for small and marginal farmers.**

- **This machine is capable of direct drilling wheat into ≤ 5 t/ha of rice residue.**

- **Provision has been made for the operator to ride on the MHS during its operation.**

- **It can be easily detachable from the two wheal tractor after seeding.**

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Zero till seed-cum-ferti drill

Direct zero-till drilling offers the apparent advantage of timely planting at:

Reduction in: time, fuel, labour and drastic reduction in tillage intensity

Saving in: cost, energy and carbon

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Movie seed cum fertiliser drill

PRODUCT INNOVATION – Roto seeder

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Roto Seeder :- ROTO SEEEDER is multi purpose earth tilling machine used in the preparation of seedbed & sowing seed into stubbles fields.

Roto Seeder helps in proper distribution of seed & fertilzer with broadcasting process,

Also the seed feed-rate can be adjusted with the help of adjusting lever, which allows a great extent of liberty to farmers.

It is available with rotary tillers of 150, 18, 210 and 240cm

Movie of Roto seeder

Source : M/s Dasmesh Mechanical work, India
www.landforce.in

Zero till seed drill (ZT)

Crop : Pea

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- Compared with zero till drill (TD) & farmer practice of relay cropping by manual dibbling

Parameters	ZTSD (TD)	ZTSD (PT)	FP
Effective working width , mm	1600	800	
Working depth, mm	45-53	31-40	
Soil moisture (%), db	18-22	18-22	23 & higher
Seed rate, kg/ha	52	52	62
Field capacity, ha/h	0.346	0.18	
Fuel consumption, l/h	4.2	1.41	
Cost of operation, Rs/ha	1236.00	779.89	1600.00
Yield, kg/ha	591	562	625

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Controlled traffic slit drill

- The controlled traffic slit drill was designed for zero till seeding in straw fields after grain combining

Raised bed planter for residue condition

Planting crops on permanent raised beds have been useful for providing better drainage during heavy rainfall condition, controlled traffic, mobility in the shown field, higher yield, increased fertilizer and irrigation efficiencies, reduced herbicides dependence.

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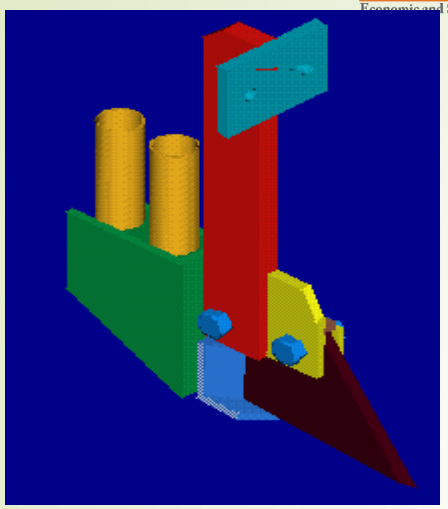


Inverted 'T' furrow opener for Zero till-drill

Energy & moisture conservation

Saving in time : 40-70%

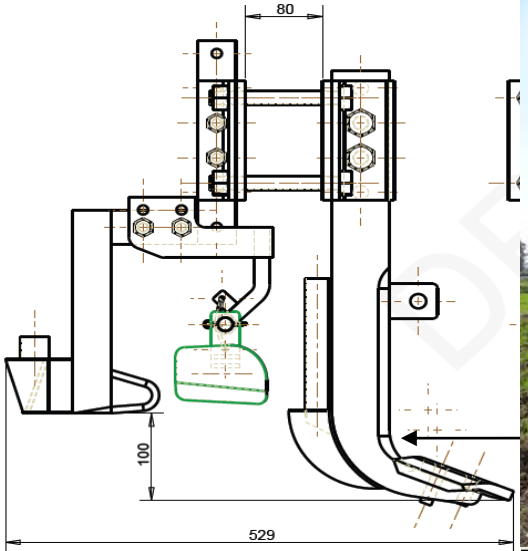
Saving in fuel : 64%

Saving in water:10-15 %

Zero till-drill in operation

(5 million ha area)

Equipment	Outputs
Seed-cum-ferti drill with differential depth fertilizer application system	• Fertilizers are efficiently utilised by plants at 15 cm depth of application and parallel results were observed for 10 cm depth also • Placement of fertilizer at depth 150 mm required 47% and 42% higher draft and power, respectively, as compared to 10 cm, resulting in higher cost of production at 150 mm depth placement without significant gain in yield • Fertiliser placement at 100 mm depth was found optimum



Inclined Plate Planter with Broad/narrow Bed Former

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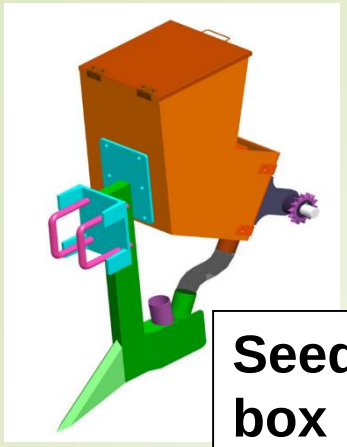
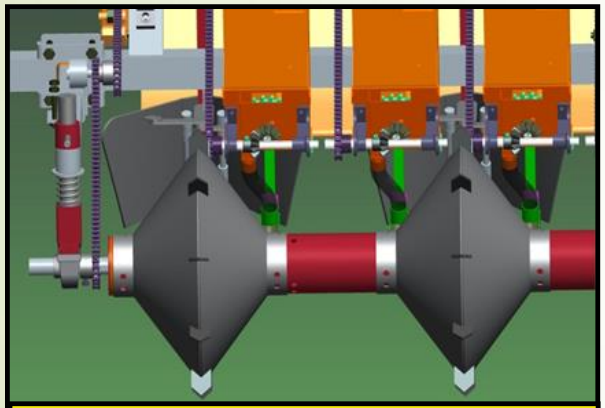


Seed box



Raised bed former

Raised bed former-cum-planter

Two different treatments of narrow bed planting of wheat

Rotary assisted bed maker-cum-seeder

L x W x H, mm	: 1760x2600x1160
No of furrow openers	: 5 (up to 11)
Type of furrow openers	: Shovel
Metering mechanism	: Fluted roller
Weight, kg	: 550
Rotavator (lxwxh, mm)	600 x 1880 x 720
No. of rotors	: 8
No. of blades in both end rotor	: 3
No. of blades in each rotor	: 6
Total number of blades	: 45
Speed reduction	: 2.85
Lower hitch height from ground	: 470 mm
Upper hitch height from ground	: 1020 mm
Distance between lower hitch	: 700 mm
Mast height	: 550 mm

Raised bed planters for pulse

Treatments

3 makes

- Dashmesh
- National
- Khedut

2 crops

- Green gram

- Black gram

2 Season

- Kharif
- Summer

Multi location Trials

Case Study

Raised bed planters for pulse

Case Study

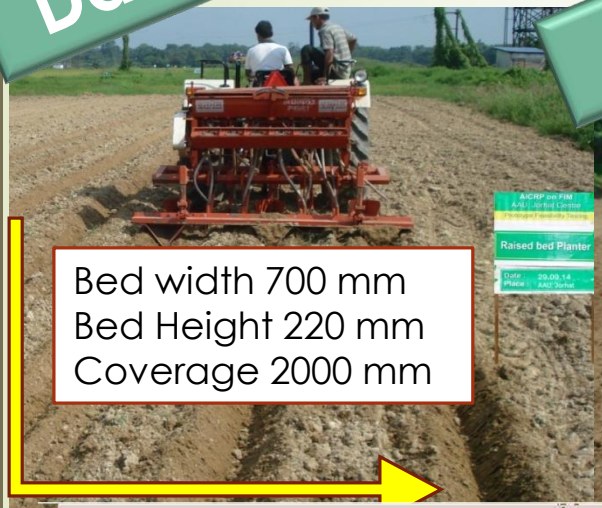
Results

Excellent

Dasmesh

National

Khedut



Bed width 700 mm
Bed Height 220 mm
Coverage 2000 mm

Bed width 600 mm
Bed Height 200 mm
Coverage 1500mm

Bed width 600 mm
Bed Height 150 mm

	Dashmesh	National	Khedut	Line sowing
Working width , mm	2000	1500		
Metering	Fluted roller	Fluted roller	Cup feed	
Field capacity, ha/h	0.378	0.392	0.372	
Fuel consumption, l/ha	1.48	1.435	1.384	
Cost of operation, Rs/ha	1418	1405	1014	16000

Developed CAM 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, $	**465**	**925**	**1075**	**850**	**310+ 390**
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

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FERTILISER MANAGEMENT and PLANT PROTECTION

Fertilizer Management

Nitrogen fertilizers are not always used efficiently by crops. Increased N use efficiency would reduce N_2O emissions

- **Adjusting N application based on crop needs (e.g., precision farming) and least susceptible to loss (improved timing)**
- **Use of slow- or controlled-release fertilizer or nitrification inhibitors (which retards the microbial processes of N_2O formation)**
- **N placement more precisely into the soil to make it more accessible to crops roots**
- **Avoiding N applications in excess of immediate plant requirements.**

Adoption of Precision Machinery for Fertilizer and Chemical applicators

- Variable rate fertilizers applicator with real time sensors could save 10-15% fertilizer.
- Band width applicator for placing the fertilizer for higher input use efficiency
- Fertigation system for N application with higher input use efficiency

Pre-emergence herbicide strip applicator

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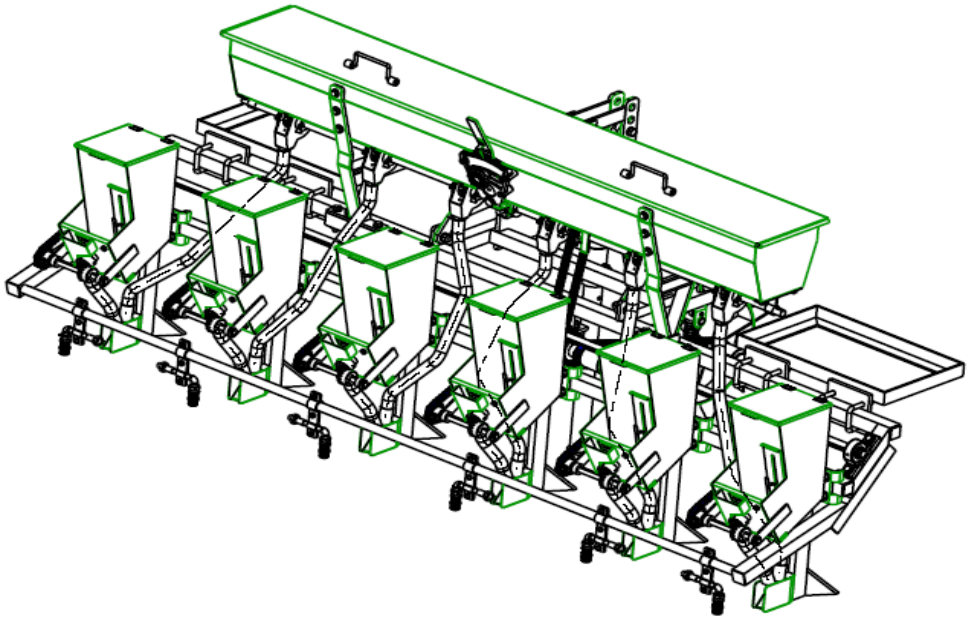

Plant Protection Equipment

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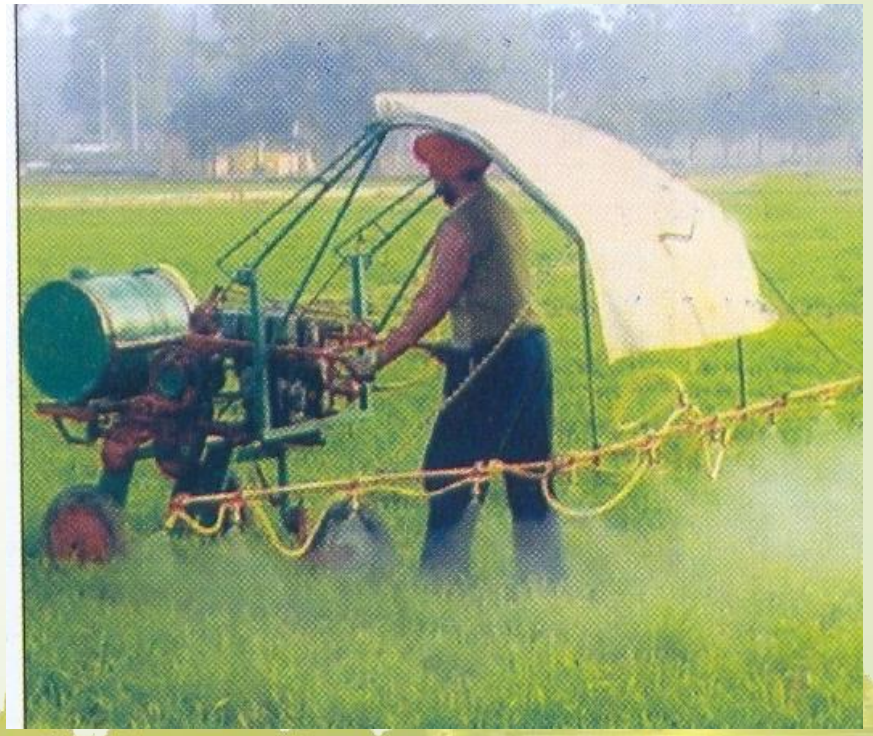
Power tiller operated sprayer



Self-propelled sprayer

Intra Canopy Sprayer for pigeon pea and cotton crops

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Residue Management

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Surplus of crop residues in India (million tonne year^{-1})

Residue generation (MNRE, 2009)	Residue surplus (MNRE, 2009)	Residue burned (Pathak et al. 2010)
501.76	140.84	92.81

- **Emissions due to Burning of crop residue in India : 6.606 million tonnes equivalent CO_2 emission/year (INCCA-2010).**

In-situ management of paddy straw

- Incorporation of paddy residue into the soil using
  - Conventional tillage methods
  - Straw chopping and mixing using tillage tools
- Retention of paddy straw as mulch on soil
  - Sowing of wheat using happy seeder
  - Straw chopping and sowing of wheat using spatially modified no-till drill

Residue Management

Removal/collection of paddy straw

- Farm residue collector
- Baling of paddy straw
- Collection of whole straw using head feed combine

Straw incorporated tillage seeding

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STRAW CHOPPER

Movie of Straw Chopper

Source : M/s Dasmesh Mechanical work, India
www.landforce.in

Movie of Straw mulcher

Source : M/s Dasmesh Mechanical work, Indi
www.landforce.in

Tractor operated straw reaper (combine)

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STRAW REAPER

Tractor operated straw reaper with trailer

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Field capacity : 0.4 ha/h
Cost: $ 5000

Movie of Straw reper

Source : M/s Dasmesh Mechanical work, India
www.landforce.in

Hay rake in operation to collect paddy straw

Straw baler being used to make bales of paddy straw

New Innovation : Super straw management system

Movie of super straw management system

Source : M/s Dasmesh Mechanical work, India
www.landforce.in

Future challenge !!

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Management of Standing Crop Residues

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Reformation of bed following harvest of maize with full maize prior to wheat planting

Partial removal of wheat straw for fodder if economically feasible prior to bed reformation

Rolling Down Maize Straw

Chopping maize straw after harvest

Roller for Managing Standing Crop Residues Instead of Chopping

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CA for Sustainable Intensification of Rice-Wheat System: Relay planting of Green gram (Pulses) in wheat

- **System sustainability through inclusion of legume in cereal rotations**
- **Increase profits**
- **Nutritional security**
- **Improve soil health**
- **Buffer canopy temperature-adaptation**
- **Eliminate wheat stubble burning**

CA in Cotton-Wheat Systems

CA in Maize Systems

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- Cotton-wheat, 2nd largest wheat systems in South Asia (>4.5 mha)

CA in Sugarcane Systems

Energy Flow in Wheat Production in Punjab

Operational Energy (MJ/ha)

Seedbed Pre.	Irrigation	Har. & Thr.	Weeding	Others
(1454)	(3516)	(3166)	(129)	(947)

Material Input Energy (MJ/ha)

(10152)

Total Energy Input (Operational + Material) 19364 MJ/ha

Output Energy 148810 MJ/ha

Grain	Biomass
61490	87320

Indian Scenario

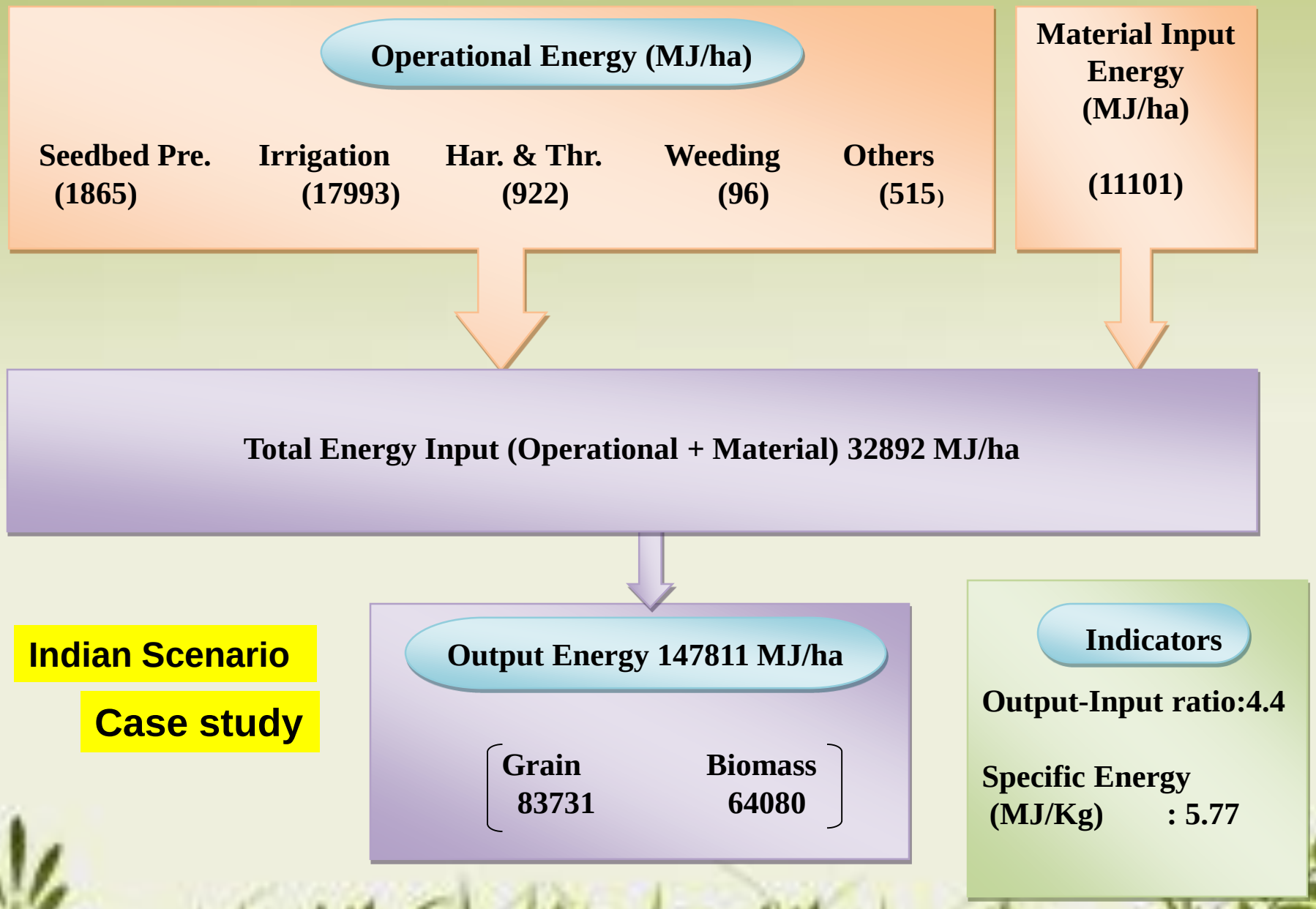
Case study

Indicators

Output-Input ratio:7.6

Specific Energy (MJ/Kg) : 4.63

Energy Flow in Paddy Production at Punjab



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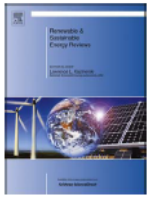
Crop Residue Burning is a BIG Challenge

Renewable and Sustainable Energy Reviews 81 (2018) 693–706

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

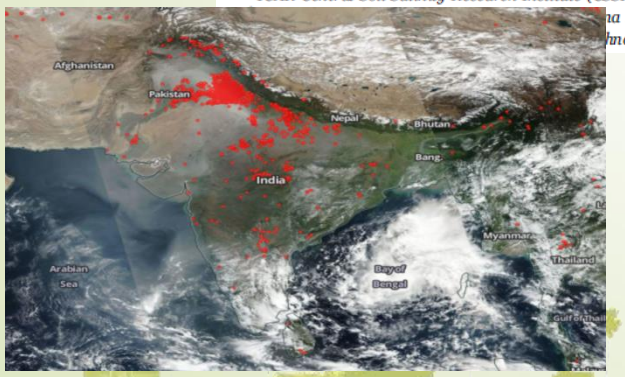
journal homepage: www.elsevier.com/locate/rser



Burning issues of paddy residue management in north-west states of India

Shiv Kumar Lohan[a], H.S. Jat[b,*], Arvind Kumar Yadav[c], H.S. Sidhu[d], M.L. Jat[b], Madhu Choudhary[c], Jyotsna Kiran Peter[e], P.C. Sharma[c]

[a] Department of Farm Machinery & Power Engineering, Punjab Agricultural University, Ludhiana 141004, India
[b] International Maize and Wheat Improvement Centre (CIMMYT), NASC Complex, New Delhi 110012, India
[c] ICAR-Central Soil Salinity Research Institute (CSSRI), Karnal 132001, India
[a] na 141004, India
hnology and Sciences (SHIATS), Allahabad 211007, India



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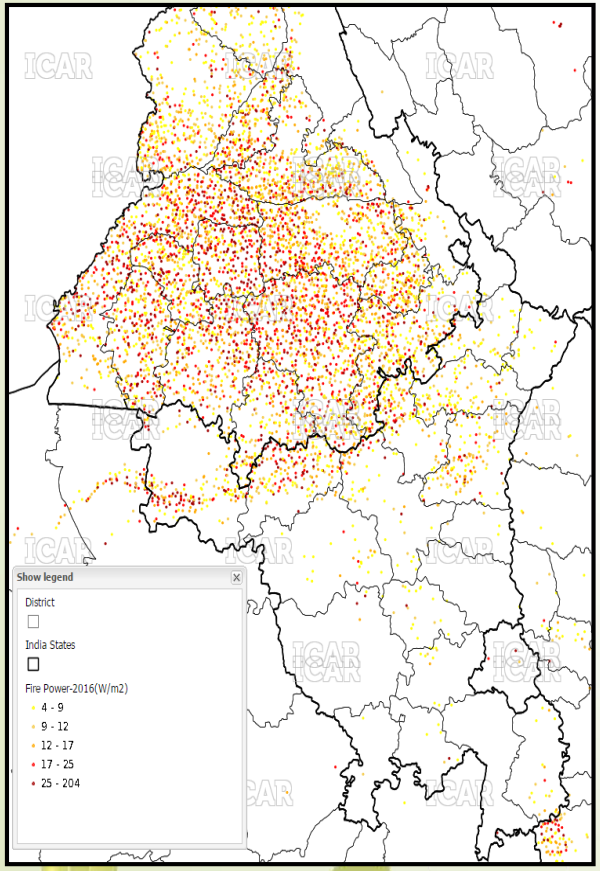
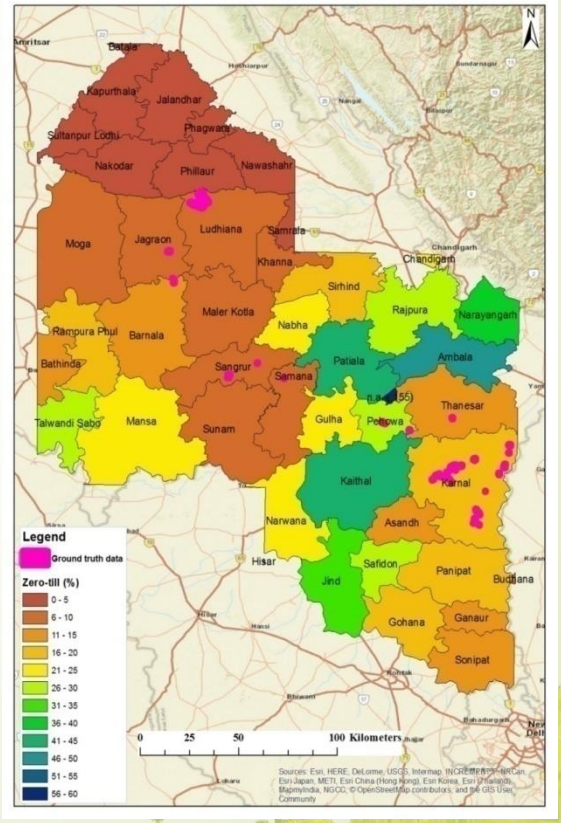
Rice Residue Burning during 2016



Estimates on Adoption of Zero Till Wheat in Haryana and Punjab Using Remote Sensing (Winter 2016-17)



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CA based Innovations for Managing Crop Residues

Field Crops Research 184 (2015) 201–212

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

Development and evaluation of the Turbo Happy Seeder for sowing wheat into heavy rice residues in NW India

H.S. Sidhu[a], Manpreet Singh[b], Yadvinder Singh[b,*], J. Blackwell[c], Shiv Kumar Lohan[b], E. Humphreys[d], M.L. Jat[e], Vicky Singh[b], Sarbjeet Singh[f]

Intervention by Government of India

UNITED NATIONS ESCAP Economic and Social Commission for Asia and the Pacific CSAM

Jan 25, 2018

Budget 2018: Govt earmarks Rs 1,000 crore fund to reduce stubble burning, air pollution in NCR

Updated Jan 25, 2018 | 17:14 IST | ET Now Digital

A - A +

it has also been learnt that a flat subsidy of 50 percent (on purchase price) will be provided to individual farmers willing to buy machinery.

Rs 1,000 crore plan to curb stubble burning, air pollution in NCR

Amit Anand Choudhary| TNN | Updated: Jan 25, 2018, 14:45 IST

A- A+

HIGHLIGHTS

- The budgetary allocation will be spent on various schemes, including help to farm cooperatives and others, to stifle the sources of air pollution.
- A flat subsidy of 50 per cent of purchase price will be given through a direct benefit transfer mechanism to individual farmers willing to buy the machines.

Govt of India in the recent budget allocated Rs 1000 crores (153 lakh USD) to reduce stubble burning

Flat 50 % subsidy will be given to the individal farmers who are willing to buy the equipment for straw management

Government support & policy decision very important

Brief of cost of the equipment

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S No	Product Name and Model	Product Image	Ex-Factory (Rupees)	Ex-Factory (USD)
1	Laser Land Leveler (Std. Model) (LLN2A)		3,20,000	4923
2	Laser Landleveler (Sport Model) (LLS2A)		3,25,000	5000
3	Happy seeder (10 Tine) (HSS10)		1,45,000	2230
4	Roto seeder heavy duty (7 Feet) (RH7MG48)		1,25,000	1923

Only indicative

Brief of cost of the equipment

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			Rs	USD
5	Seed cum fertilizer drill (11 tine) (SDD11)		49,000	754
6	Zero seed drill (11 Tine) (ZDD11)		49,000	754
7	combine harvester with SMS		22,00,000	33846
8	Straw Mulcher (2 meter) (CSB)		1,45,000	2231
9	Straw reaper (SR56)		2,25,000	3461

Only indicative

To conclude

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- **Future farm mechanization is through mechanical sources of power**
- **CA will demand to work in close partnership with farmers, stakeholders, Government to strengthen knowledge**
- **CA offers an opportunity for arresting resource degradation and make agriculture more resource use efficient, competitive and sustainable**
- **Machines suitable for custom hiring – high capacity, high labour productivity**
- **Quality manufacturing and after sales support for reliability of farm machinery.**

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THANK YOU

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