Sustainable Mechanization Solutions to Agricultural Waste Burning

Anshuman Varma
Programme Officer and Deputy Head
Centre for Sustainable Agricultural Mechanization (CSAM)
United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)

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About CSAM

• Mandate: To promote knowledge exchange, research and development, technology transfer and agro-business development for sustainable agricultural mechanization

• Regional Hub for South-to-South and Triangular Cooperation directly serving 62 ESCAP member States and associate members

• Focus on Sustainable Development Goals (SDG) 2 (Zero Hunger), SDG 1 (No Poverty), SDG 13 (Climate Action), SDG 17 (Partnerships for the Goals).

CSAM’s vision is to achieve production gains, improved rural livelihood and poverty alleviation through sustainable agricultural mechanization for a more resilient, inclusive and sustainable Asia and the Pacific
Why Do Farmers Burn Straw?

• No perceived economic value due to lack of alternative uses
• High cost of straw collection, transportation and storage, partially caused by the shortage of rural labour
• Lack of time for straw to decompose before next seeding cycle
• Lack of adequate machinery and techniques to treat straw residue
• Low awareness of the impacts of burning on the environment, food security and health

Picture courtesy: ICAERD (Indonesia)
Some Alternative Uses of Straw

• **Fertilizer** (directly or as cow manure)
• **Fodder**
• **New energy resource** (briquette fuels, biogas production, carbonization fuel, gasification fuel, degradation and ethanol)
• **Base stock** (mushroom growing)
• **Industry material** (papermaking, building material, crafts production, xylitol production)

*Pictures courtesy: China Agricultural University, SIAEP (Viet Nam)*
CSAM’s Regional Initiative on Integrated Management of Straw Residue: Circular Model of Straw Utilization

Promoting application of agricultural machinery and practices for sustainable, circular use of straw residue as fertilizer, fodder, substrate for mushroom-growing, and biogas production

Priorities for country pilots (on wheat-maize system and extended to rice):

• Sensitize stakeholders and **highlight economic benefits** of sustainable & integrated straw residue management to farmers

• **Incentivize adoption** of sustainable mechanization solutions and encourage **adaptation** to match local needs
Technical Mode: Straw Used as Fertilizer

1) Returning straw to the field

a) Wheat harvesting and straw chopping
b) Maize no-till planting
c) Maize harvesting
g) Seedling emergence
f) Sprinkling irrigation
e) Wheat planting
d) Straw chopping and mixing with soil

Pictures courtesy: China Agricultural University
Technical Mode: Straw Used as Fertilizer

2) Returning cow manure to the field

- a) Feeding cows
- b) Cow manure composting in fertilizer processing factory (using cow manure rotator)
- c) Sewage disposal through cow manure drain trap
- d) Dry-wet cow manure separation
- e) Returning cow manure to the field
Technical Mode: Straw Used as Fodder (Ensilage Maize)

- a) Maize harvested by maize ensilage harvester
- b) Compacting straw
- c) Straw fermentation
- d) Processing fodder
- e) Feeding cows

Pictures courtesy: China Agricultural University
Technical Mode: Returning Biogas Slurry/Residue to the Field

a) Bio-gas production

b) Separation of biogas slurry/residue

d) Returning biogas slurry (with water) to the field (After winter wheat germination)

c) Returning biogas residue to the field (Before winter wheat planting)

Pictures courtesy: China Agricultural University
Technical Mode: Straw as Base Stock for Mushroom Growing

- a) Base material preparation
- b) Bagging
- c) Sterilization
- d) Mushroom inoculation
- e) Mushroom cultivation
- f) Harvesting

Pictures courtesy: China Agricultural University
Pilot Project on Integrated Straw Management in China (wheat-maize system)

- With China Agricultural University and local farmers cooperative
- Positive outcomes (July 2019 to Aug 2022):
  - 1,000 tons of wheat and maize straw sustainably utilized from 23 ha pilot demonstration site in 2022 amounting to an equivalent emissions reduction of 1,579 tons of CO₂ per year
  - Soil Organic Matter increased under different approaches (returning straw to the field, returning cow manure to the field and returning biogas slurry & residue to the field) by up to 11.4%
  - New formula for cattle fodder + kneading machine during ensilage process improved milk production by 3 ltr/day/cow, increasing value of milk produced by 160 USD/day for 100 cows
  - Increased net income under different approaches by up to 539 USD/ha

Pictures courtesy: China Agricultural University
Pilot Project on Integrated Straw Management in Viet Nam

- With Sub-Institute of Agricultural Engineering and Post-Harvest Technology

- Positive outcomes (2018 to 2019):
  - Promoted ‘In-door mushroom growing technology’ applying a steam sterilizer and water supplying system
  - Indoor mushroom growing technology demonstrated as superior to traditional/ outdoor method:
    - **Higher mushroom yield** - rice straw using efficiency of approximately 26% compared to 13-15% in traditional method
    - **Lower production cost**
    - **Higher mushroom quality**
  - Substrate after mushroom growing used as a natural fertilizer - considerably **reduced application of chemical fertilizers** and lowered production cost
  - **Improved porosity and fertility of soil** & reduced negative impact on environment from straw burning

Pictures courtesy: SIAEP (Viet Nam)
Regional Initiative Extended to New Pilots in Cambodia, Indonesia and Nepal (2021-2023)

- **Approach implemented:**
  - Establishment of pilot sites
  - Field trials of machinery
  - Modification and adaptation of the machinery
  - Capacity building and community awareness sessions
  - Regional study tours for knowledge exchange

- **Pilot Model:**
  - In-situ and ex-situ utilization of straw (e.g. as fodder and fertilizer) based on local needs
  - Machinery used: Minimum-tillage seeder, baler, direct seed drill, handy straw cutter…

- **Results:**
  - Increased farmers’ awareness
  - Identification of smallholder-friendly solutions
  - Strengthened local capacities

Pictures courtesy: Dept. of Agri Engg (Cambodia), Gadjah Mada University (Indonesia), Tribhuvan University (Nepal)
Pilot Project on Integrated Straw Management in Cambodia
(with Swisscontact and Dept of Agricultural Engineering)

Balers
Can compress loose straw into compact round or rectangular ‘bales’ that are easier to store and transport

Direct Seed Drill
Can shorten time needed for crop to mature & allow more time for residue to decompose naturally

Pictures courtesy: Dept. of Agri Engg (Cambodia)
Pilot Project on Integrated Straw Management in Indonesia
(with Gadjah Mada University)

Handy Straw Cutter  Thresher  Customized Straw Pressing Machine for compact storage  Trailer for Straw Transportation

Low-cost, Smallholder-friendly Equipment & Solutions

Pictures courtesy: Gadjah Mada University (Indonesia)
Pilot Project on Integrated Straw Management in Nepal
(with Institute of Engineering, Tribhuvan University)

Super Seeder / Minimum-Seed Drill
Can incorporate paddy straw & stubble into soil and simultaneously sow seeds

Field Trial
Left side control plot (traditional) & right side (Super Seeder)

Drum Seeder
Low-cost solution, can shorten time for crop to mature

Straw Block-making Machine
for straw use as fodder

Pictures courtesy: Tribhuvan University (Nepal)
Regional Knowledge Exchange

Integrated Straw Management Regional Study Tour, 7-10 November 2019, Ludhiana, India

Virtual Workshops and Demonstrations, 28 October 2020 & 25 October 2022, Laixi, China

Regional Study Tour on Mechanization Solutions for Straw Management, 21-27 November 2022, Thailand
Won ESCAP Innovation Award & ‘best business pitch’ - Nov. 2022
Key Implementation Needs

Alternative uses of straw – supported by agricultural machinery - can provide sustainable solutions for burning but we need:

• Identification of context-specific options
• Local adaptation
• Community engagement and local champions
• Training and capacity building
• Multi-stakeholder approach
• Field-level regional / international exchanges and cooperation
Thank you for your attention!

For more information, please visit www.un-csam.org

or email escap-csam@un.org