

CSAM's Regional Initiative on Integrated Straw Management

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CSAM

Centre for Sustainable
Agricultural Mechanization

About ESCAP-CSAM

- **Regional institution** of United Nations ESCAP hosted in China since 2003
- **Vision:** 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.
- Dedicated to promoting **international cooperation and partnership** in sustainable agricultural mechanization.
 - Asia-Pacific regional hub for **South-to-South and Triangular Cooperation** servicing **62 ESCAP member States and associate members**.
- Focusing on **Sustainable Development Goals (SDG) 2 (Zero Hunger), SDG 1 (no poverty), SDG 13 (Climate Action), SDG 17 (Partnerships for the Goals)**

SUSTAINABLE
DEVELOPMENT
GOALS

1 NO
POVERTY



2 ZERO
HUNGER



13 CLIMATE
ACTION



17 PARTNERSHIPS
FOR THE GOALS



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Burning of Crop Residue

Crop residue burning is a serious, **transboundary** concern in many countries in the Asia-Pacific region leading to:

- **Soil deterioration:** negative impact on soil nutrients, pH, moisture, organic matter, fertility
 - **Environmental concerns:** Air pollution, transboundary haze, GHG emissions
 - **Social impacts:** Public health hazard, transportation disruptions
- **Residue burning not aligned with sustainable intensification in agriculture**



Table 4 Main crop straw production in the targeted East Asia countries (Mt/yr) (FAOSTAT, 2014)

Crop	Straw-grain ratio	China		Japan		Republic of Korea	
		Grain	Straw	Grain	Straw	Grain	Straw
Rice	1.28	208.24	266.55	10.55	13.50	5.64	7.22
Wheat	1.38	126.22	174.18	0.85	1.18	/	/
Maize	2.05	215.81	442.41	0.25	0.51	/	/
Potato	1.16	95.57	110.86	2.46	2.85	0.59	0.69

Table 5 Major crop straw production in some South Asia countries (Mt/yr) (FAOSTAT, 2014)

Crop	straw-grain ratio	India		Bangladesh		Nepal		Sri Lanka	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Rice	1.28	108.8	139.26	34.57	44.25	4.95	6.33	4.50	5.76
Wheat	1.38	96.6	133.30	1.30	1.79	1.57	2.16	/	/
Maize	2.05	26.15	53.60	2.75	5.63	2.20	4.50	0.24	0.48

Table 6 Rice straw yield in the targeted Southeast Asia countries (Mt/yr)

Crop	Straw-grain ratio	Indonesia		Vietnam		Myanmar		Thailand	
		Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Rice	1.28	70.84	90.68	44.07 ^a	49.59 ^b	26.42	33.82	32.62	41.75
Wheat	1.38	-	-	-	-	0.186	0.256	0.001	0.00028
Maize	2.05	18.51	37.94	5.19	10.64	1.60	3.28	4.87	9.98

(Source: FAOSTAT, 2014)

Crop Residue in Asia

South and Southeast Asia alone generate an estimated >400 Mt of rice straw a year.

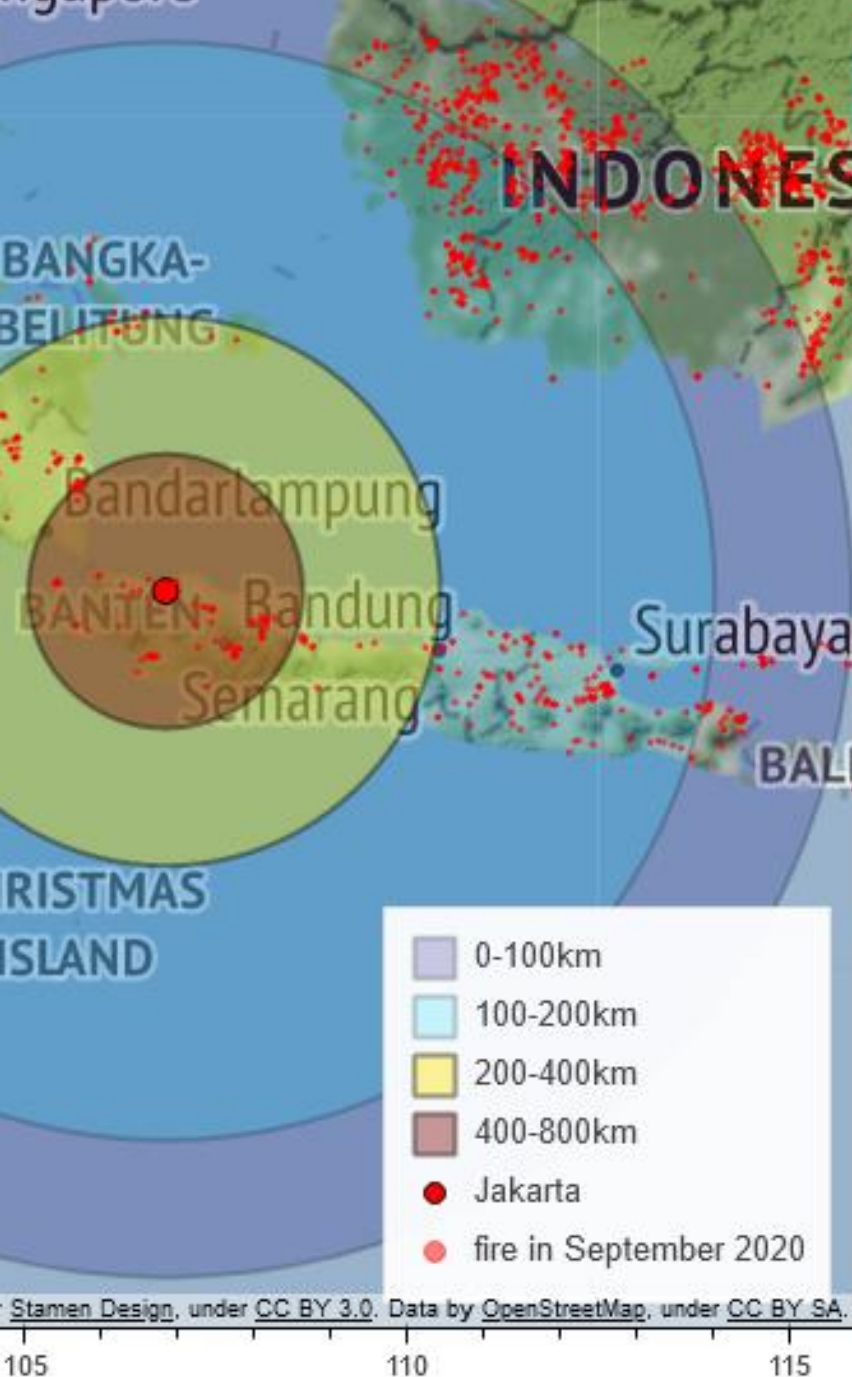
Source: *Status of Straw Management in Asia-Pacific and Options for Integrated Straw Management (CSAM, 2018)*

- **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

Key reasons for straw burning



Picture courtesy: Tribhuvan University, Nepal



Collaboration with ESCAP EDD Regional Action Programme on Air Pollution

Innovative approaches to data bringing the insight necessary to guide action and policymaking

- Applying machine learning to interpret ground base sources on chemical compounds
- Identifying **hotspots** and their repeating patterns
- Understanding the **impact of a particular policy action** on air pollution
- Through the Regional Action Programme on Air Pollution, ESCAP is supporting countries to reduce their emissions

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)

Fertilizer (mixing w/ soil)



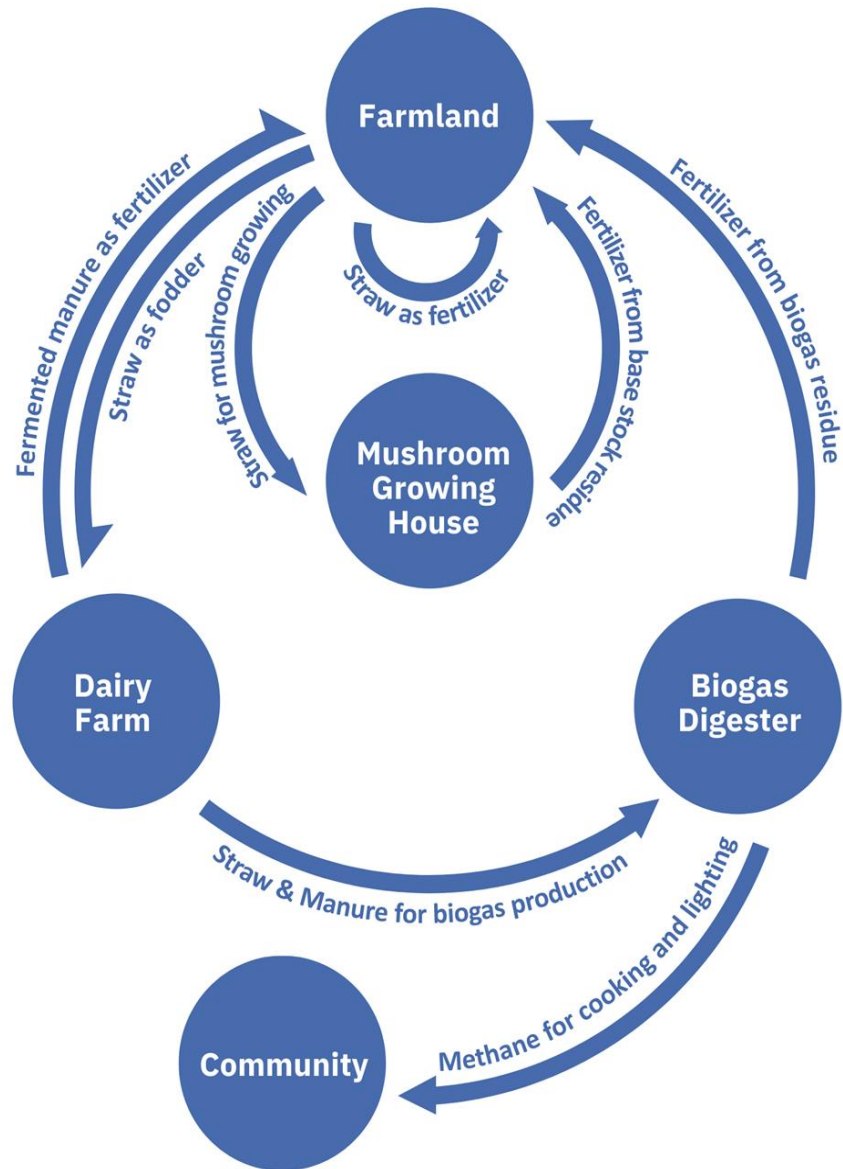
Fodder



Bio-gas

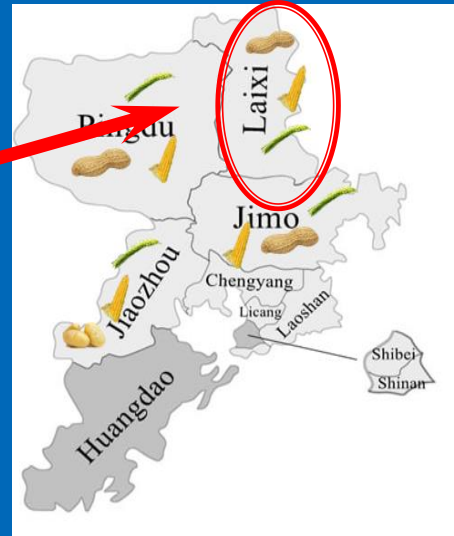


Base stock (mushroom)



CSAM Regional Initiative on Integrated Management of Straw Residue: Circular Model for 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 (so far mostly on wheat-maize system—being 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



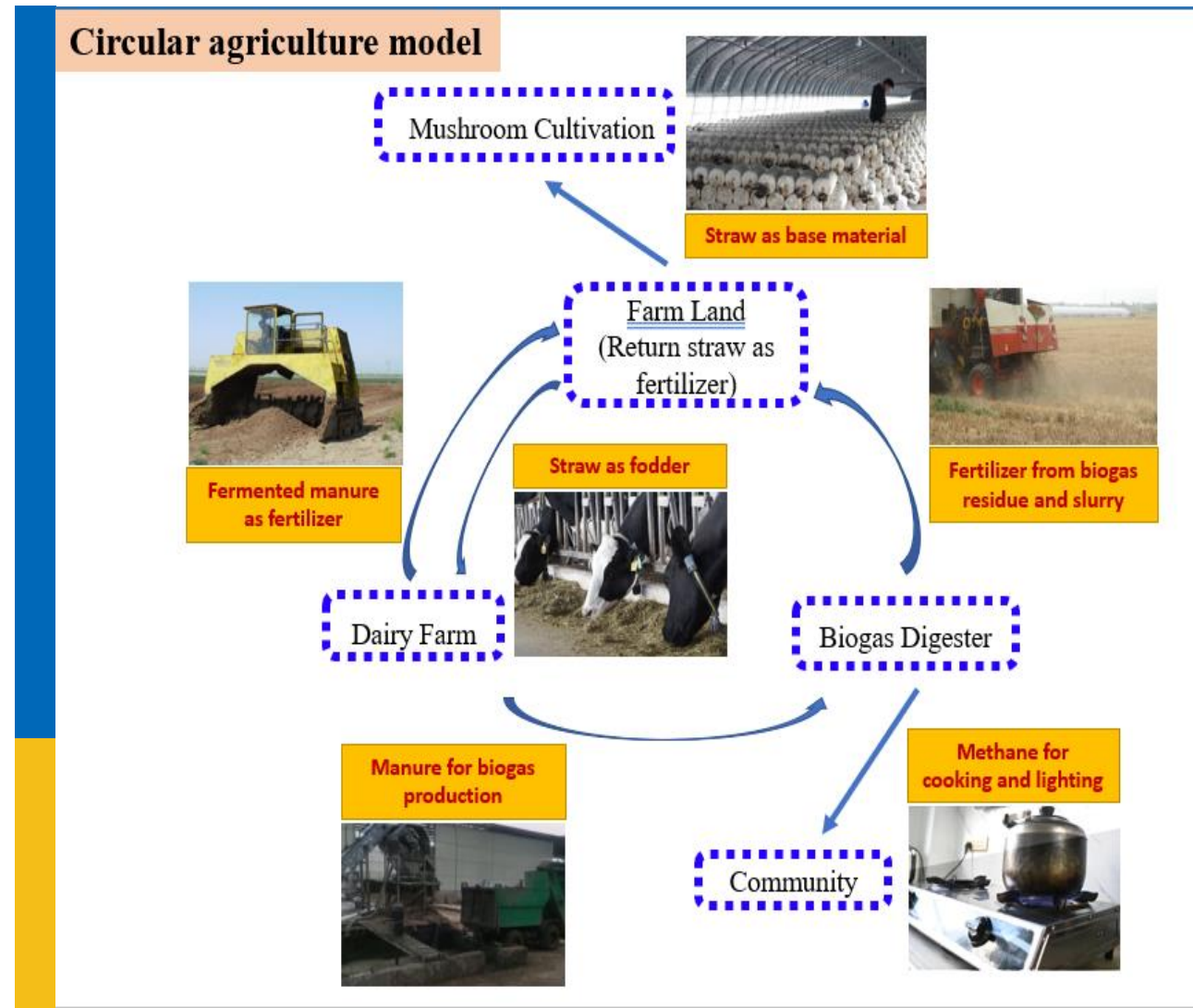
Picture courtesy: CSAM

Pilot Project on Integrated Straw Management in China (wheat-maize system)

- Multi-stakeholder effort engaging research institutions, local government and local farmers cooperative:
 - CSAM
 - China Agricultural University
 - Qingdao Agriculture and Rural Affairs Administration
 - Laixi Agriculture and Rural Affairs Administration
- Use of straw as fertilizer, fodder, new energy resource and substrate

Pilot Project on Integrated Straw Management in China (wheat-maize system)

- The demonstration areas for returning biogas slurry and residue to the field, returning straw to the field, returning cow manure to the field and ensilage maize were 3ha, 10ha, 10ha and 50ha, respectively.
- The total number of cows for the demonstration was 400.
- Area of greenhouse for mushroom planting (ha) was 0.4 ha.





Pilot Project on Integrated Straw Management in China (wheat-maize system)

- **Positive outcomes (2019 to 2023) – Ecological benefits:**
 - **2,771 tons of straw were utilized sustainably instead of burning at the pilot site through this project.**
 - **Soil Organic Matter increased by over 0.2% in average over a 3-year period, from initial value of 2.1 to 2.3% .**
 - **70.25 tons of cow manure were returned to the field per ha as organic fertilizer**

Pilot Project on Integrated Straw Management in China (wheat-maize system)

- **Positive outcomes (2019 to 2023) – Economic benefits:**
 - Overall, the total net incomes from agricultural production at the pilot site were increased by 2.7% to 9.5% for different models across the period in 2019-2022
 - Net income from sustainably returning straw to the field and returning cow manure to the field increased by 456 USD/ha and 525 USD/ha per year respectively
 - New formula of cattle fodder from ensilage process improved milk production by 1 ltr/day/cow, increasing value of milk produced by 69 USD/day for 100 cows
 - **The mushroom production** was 162,000 kg/ha, its value was 178,200 USD/ha, and the net income was 96,200 USD per ha.





Pilot Project on Integrated Straw Management in Viet Nam

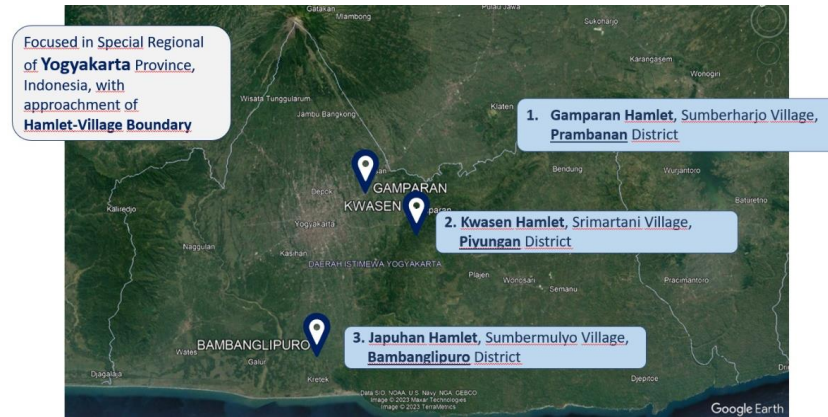
- Positive outcomes (2018 to 2019):
 - Promoted ‘In-door mushroom growing technology’ applying a steam sterilizer and water supplying system
 - Indoor mushroom growing technology demonstrated as more beneficial than traditional/ outdoor method:
 - Higher mushroom yield - rice straw using efficiency of 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 and reduced negative impact on environment induced by straw burning

Pilot Projects on Integrated Straw Management in Cambodia, Indonesia and Nepal

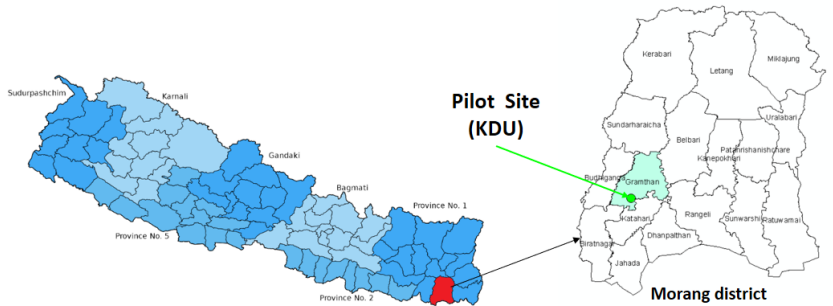
Pilot site locations



Cambodia (1 pilot site):
Field at Agricultural Engineering Station, Sronger Commune, Treang District, Takeo Province



Indonesia (3 pilot sites): Gambaran Hamlet, Sumberharjo Village, Prambanan District; Kwasen Hamlet, Srimartani Village, Piyungan District; and Japuhan Hamlet, Sumbermulyo Village, Bambanglipuro Districts; Special Region of Yogyakarta Province



Nepal (1 pilot site): Field and Plant of Krishna Daana Udhyog (KDU), Gramthan Rural Municipality Ward Number 2, Morang District, Province No. 1



Pilot Projects on Integrated Straw Management in Cambodia, Indonesia and Nepal

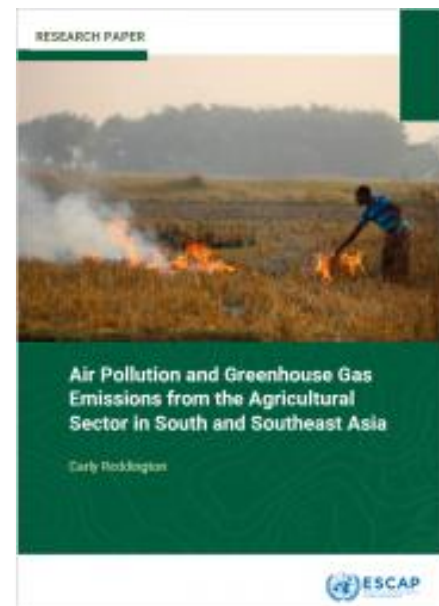
- Three community-centred learning and demonstration resource sites were established in the form of pilot sites in Cambodia, Indonesia and Nepal.
- The pilot sites were equipped with in-situ and ex-situ machinery and equipment and the performance of the machinery under local conditions was assessed including:
 - Super seeder in Nepal
 - Baler and direct seed drill in Cambodia
 - Straw chopper, handy straw cutter and power thresher in Indonesia

Pilot Projects on Integrated Straw Management in Cambodia, Indonesia and Nepal

Positive Outcomes

- The agricultural mechanization index was increased at the pilot locations in Indonesia from 0 - 0.39 horsepower per hectare (HP/ha) prior to the pilot project to 1.32 - 2.46 HP/ha after implementation, with accompanying benefits for overall productivity.
- In Nepal, application of the machinery led to increase in the benefit-cost ratio from 1.99 (control plot) to 2.59 (experimental plot) implying more profit for the farmers.
- Strong community engagement and local ownership of project results by key stakeholders was achieved and the **awareness** of the local farming communities about the harmful effects of straw burning was increased and their **capacities** to use agricultural machinery to address the problem were strengthened.
- Reached a total of 443 farming community members, among which 38% are women.





Pilot Projects on Integrated Straw Management in Cambodia, Indonesia and Nepal

- Policy Briefs Series on 'Reducing the Need to Burn: How Applying Sustainable Agricultural Mechanization can Improve Air Quality' for Cambodia, Indonesia, Nepal, South and Southeast Asia
- Sustainable Management of Crop Residues in Bangladesh, India, Nepal and Pakistan: Challenges and Solutions
- Research Paper on Air Pollution and Greenhouse Gas Emissions from the Agricultural Sector in South and Southeast Asia

Regional Knowledge Sharing Events in India, China and Thailand



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



Virtual Workshop and
Demonstration, 28 October
2020, Laixi, China



Integrated Straw
Management Regional
Study Tour, 21-27 November
2022, Chainat Province,
Thailand

Sustainable Agricultural Mechanization for Integrated and Climate-Smart Straw Residue Management



Promoting mechanization-based solutions for integrated and climate-smart management of straw residue

CHALLENGE

The burning of straw residue after crop harvesting is a common concern, including in many least developed countries (LDCs) like Cambodia and Nepal. Apart from occasional greenhouse gas emissions and air pollution, straw burning causes loss of soil carbon and micro-nutrients in the long term, while adversely affecting soil temperature, pH, moisture, organic matter and agricultural production and farmers' income. In order to address its adverse impacts, various approaches are being applied to sustainably utilize straw as fertilizer, fodder, bio-energy material and so forth. LDCs like Cambodia are also actively promoting conservation agriculture in which maintaining a permanent soil cover is an important agenda. However, the lack of suitable agricultural machinery is one of the main constraints. There is hence a need to test integrated straw utilization models through enhanced application of machinery in specific country contexts, and scale-up the innovative approaches identified via South-South and triangular cooperation.

TOWARDS A SOLUTION

The Centre for Sustainable Agricultural Mechanization (CSAM) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)

NOMINATED BY

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP)

COUNTRIES/REGIONS/TERRITORIES

Cambodia, China, India, Indonesia, Nepal, Viet Nam

CONTRIBUTING PRIORITY AREAS OF THE STRATEGICAL PROGRAMME OF ACTION (SPA)

2.6

SUSTAINABLE DEVELOPMENT GOALS/TARGETS

14, 24, 132, 133

SUPPORTED BY

Ministry of Agriculture of Viet Nam in target countries and other local partners, Ministry of Foreign Affairs of China through China-ESCAP Cooperation Programme

IMPLEMENTING ENTITIES

Centre for Sustainable Agricultural Mechanization (CSAM), ESCAP

PROJECT STATUS

ONGOING

Since launching the project in 2018, positive results have been obtained from the initial pilot countries (China and Viet Nam). The regional initiative has now leveraged the South-South and Triangular Cooperation mobility and successfully secured additional donor funding to expand coverage to two LDCs (Cambodia and Nepal) in addition to Indonesia.



Prior to the launch of the Regional Pilot Project, CSAM provided preliminary support to Cambodia by co-organizing a regional workshop on mechanization for conservation agriculture in 2018 in Phnom Penh, followed by a regional meeting in 2019 in Sam Rong which highlighted the importance of permanent soil cover, maintenance and crop rotation management in the context of crop residue burning. Among the key outcomes of the training was the collaboration between international partners and the General Directorate of Agriculture of the Ministry of Agriculture, Forestry and Fisheries of Cambodia for the introduction and demonstration of an eco-friendly plow from India in Cambodia, namely the Happy Seeder. This was an important step towards promoting sustainable crop residue management in Cambodia through South-South cooperation.



The Regional Pilot Project has identified and tested a model to utilize straw as fertilizer, fodder, bio-material (e.g., for mushroom growing) and clean energy production in a circular manner to apply to the farming livelihood system while customizing the model for specific local conditions. The pilot in China is being implemented in Lian in the Shandong Province in collaboration with China Agricultural University, local government agencies and a local farmer cooperative, while in Viet Nam the pilot has been implemented in Can Tho City in collaboration with the Sub-Institute of Agricultural Engineering and Post-Harvest Technology and local farmers. The main activities - including field experiments involving agricultural machinery, data collection and analysis, optimization of the machinery and technical patterns, and training for local farmers - have contributed to improving current practices and have provided an alternative to straw residue burning, thus supporting climate-smart agriculture. For instance, in August 2021, the pilot in China has demonstrated the following ecological and economic benefits:

- 72 tons of wheat straw and 91 tons of maize straw were utilized as fertilizer rather than burning away (compared to the 10 ha pilot site, this successfully reducing an estimated 220 tons of carbon dioxide emission).
- Over the same period, in comparison to the pre-intervention levels in 2018, maize and wheat yield increased by 200 kg/ha and 1,300 kg/ha, respectively, while the net income of the farmer cooperative under the innovative technical solutions increased by 107,073 RMB.

Building upon its success and positive results, as noted above, the Regional Pilot Project is now being expanded to two LDCs (Cambodia and Nepal) and Indonesia in 2021 with funding support from China, embodying the spirit of South-South cooperation. The initiative will sustain its outcomes by mainstreaming the integrated model of straw management by engaging pilot country partners and decision-makers, as well as testing and validating the model in rural contexts such as



GOOD PRACTICES

in South-South and Triangular Cooperation in Least Developed Countries:

From the Istanbul Programme of Action to Achieving Sustainable and Resilient Development



16 March 2022

Good Practices in South-South & Triangular Cooperation in LDCs



Solution

Livestreaming the on-site agricultural machinery demonstration





CL

SA

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2nd ESCAP Innovation Awards for stakeholder engagement

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

- Identification of context-specific alternatives
- Community engagement and local champions
- Local adaptation
- Training and capacity building
- Multi-stakeholder approach
- Regional/international cooperation and exchange



Key Lessons and Takeaways

THANK YOU

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