Best practices in rice straw management

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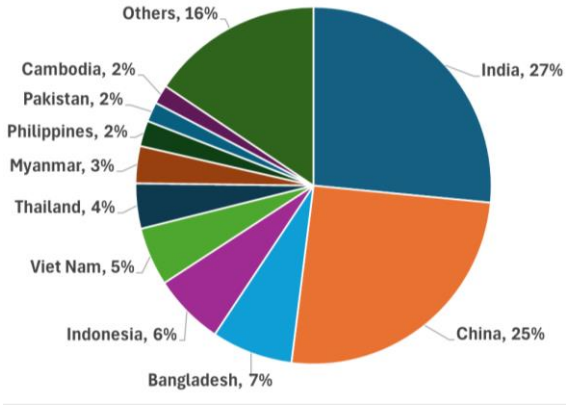
Global rice production

Global rice production is over 800 Mt (FAO, 2024)

= › produce approximately the same weight of rice residue *(ratio residue/ milled rice = 0.7- 1.4)*



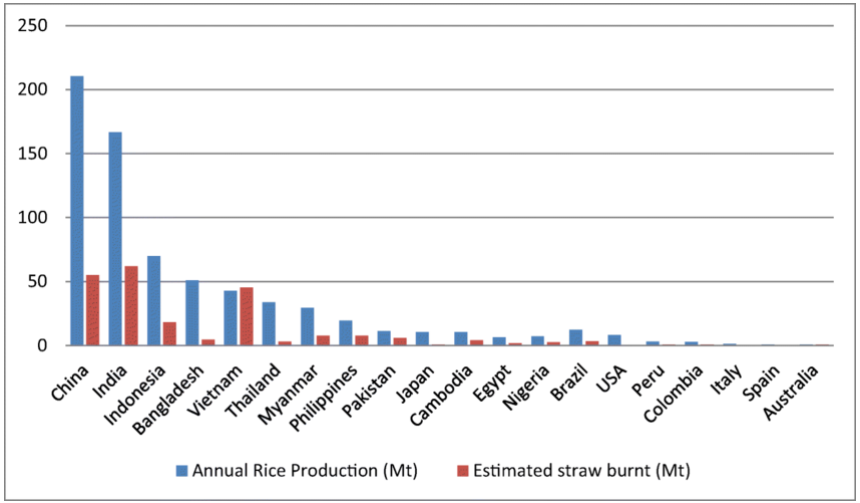
The share of rice production of top 10 rice producers (FAO, 2024)

Annually harvested rice area (*IPFRI, 2020*)

Rice residue management: Open-field burning

Pros
• Rapid and low-cost field clearing, enabling timely planting of the next crop
• Immediate pest and disease reduction
• Minimal labor and machinery requirements

Cons
• Severe air pollution (PM2.5, black carbon, toxic gases), affecting human health
• Loss of nutrients (N, S) and organic matter
• Greenhouse gas emissions (CH_4, N_2O, NOx) contributing to climate change
• Soil degradation and long-term fertility decline



Rice straw burning by country (*Gurraj Singh et al., 2021*)

Rice residue management: Straw incorporation

Pros
• Improves soil organic matter and long-term soil health
• Enhances soil structure, water retention, and nutrient cycling
• Avoids air pollution from burning
• Reduces need for external organic amendments

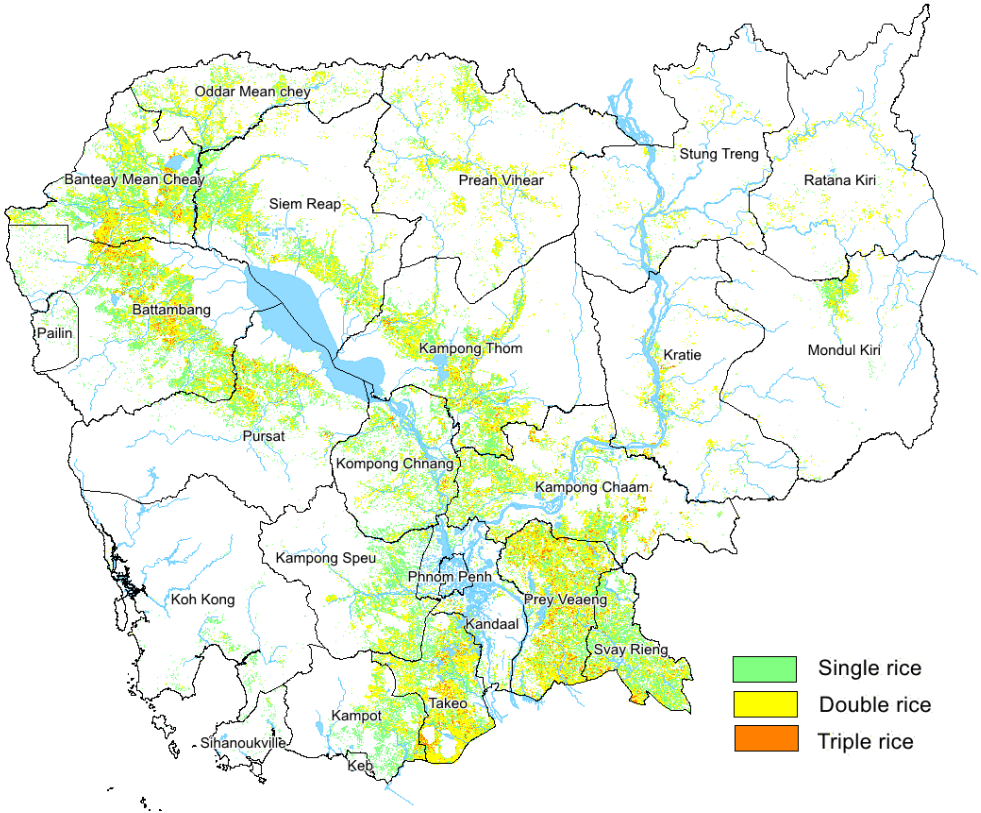
Cons
• Increased methane (CH_4) emissions under flooded conditions
• Temporary nitrogen immobilization, affecting early crop growth
• Potential formation of phytotoxic compounds (e.g., organic acids, H_2S)
• Can delay field operations and complicate mechanization, especially in wet conditions

Rice residue management: Straw removal/collection

Pros
• Reduces burning → improves air quality
• Create added values (animal feed, mushroom cultivation, bioenergy, biochar)
• Facilitates field preparation and mechanization
• Additional income source for farmers

Cons
• High costs for collection, baling, and transport
• Requires machinery access and logistics systems
• Removal of nutrients and organic carbon from field, potentially reducing soil fertility
• Market dependency

Rice straw management in Cambodia



- Harvested area: 3.9 **Mha** (FAO, 2024)

- Annual straw production: app **15 Mt**
  - Open-field burning: **25%**
  - Removal/collection: **55%**
  - Soil incorporation: **20%**

- NDC 3.0 targets by 2030:
  - Open-field burning: **0%**
  - Collection (for reuse): **75%**
  - Soil incorporation: **25%**

Develop straw value chains

Business models: 1. Straw collection and logistics

- Collection involves 3 steps: pickup → baling → transport
- Baling is essential to reduce volume and transport cost
- Density of baled straw: 73–104kg/m3
- Machines: tractor-pulled balers, self-propelled balers, gathering machines
- Capacity: 0.87–2.47 tons/hour
- Cost: USD 12–18 per ton (studies in Vietnam)

Roller baler pulled by a tractor

Self-propelled baler

Gathering machine (loose rice straw)

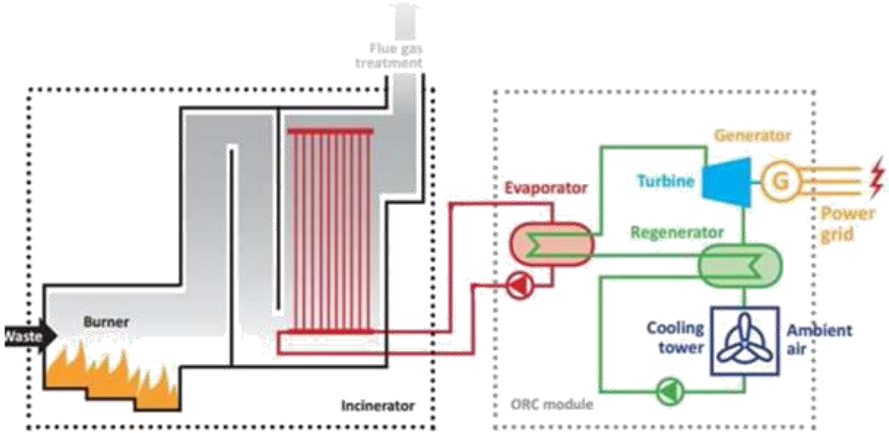
Business model: 2. Straw processing

Bioenergy

- Conversion pathways:
  - Combustion → heat/electricity
  - Anaerobic digestion → biogas
- Example: 1.2 MW plant using 15,000 tons straw/year
- Challenges: High ash, alkali, potassium & silica → equipment wear (i.e. chopper or grinder)
- Feedstock logistics required

Briquet and pellet

- Provides input for bioenergy
- Production value: USD125/ton



A 1-megawatt power plant with Organic Rankine Cycle (Guillemot et al 2014.)

Briquetting and pelletizing from rice straw

Business model: 2. Straw processing

Mushroom production

- High-value agricultural use
- Short incubation period of 14 days
- Produces 50–100 kg mushrooms per ton of straw (5–10% yield)
- Suitable for smallholders and local enterprises

Paddy straw mushroom

Biochar production and utilization

- Produces carbon-rich material for soil improvement
- Benefits: Enhances soil fertility; Increase carbon sequestration
- Constraint: high processing energy and cost (require limited oxygen supply at 500-700°C)

Business model: 3. Others alternative uses

Crop mulching material

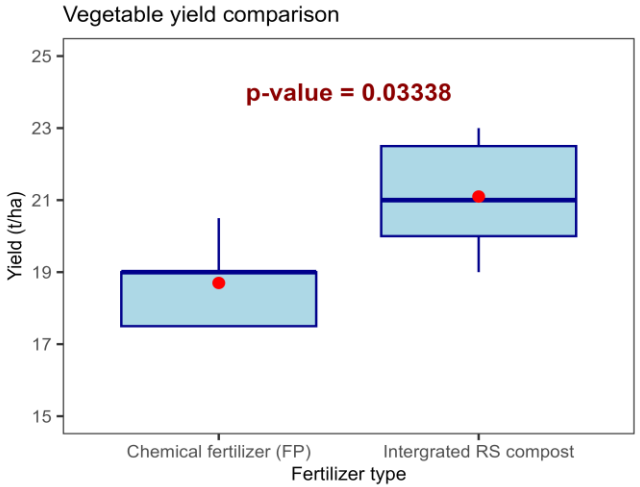
- Conserves soil moisture and reduces evaporation, limit weed growth
- Improves soil organic matter, soil structure over time and reduces soil erosion and surface crusting
- Moderates soil temperature
- Supports microbial activity and nutrient cycling
- Improve crop yields under dry or stress conditions

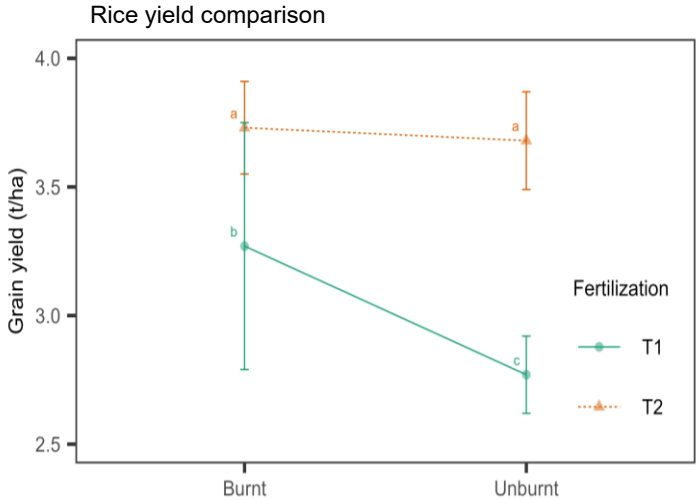
Livestock feed

- Widely used in mixed farming systems
- Provides low-cost feed supplement (1.0 to1.2 kg per 100 kg live weight)
- Straw is low in nutrients → requires treatment (e.g., urea)
- Strong demand in livestock regions

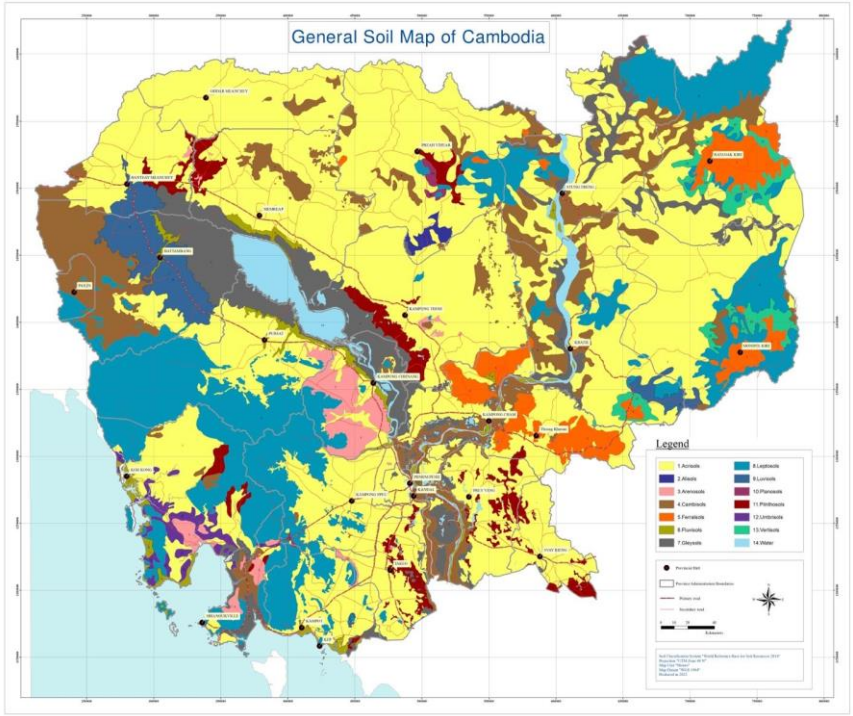
Demonstrations of straw management in Cambodia

- Mechanized rice straw compost
- Compost selling price: **285-300$/ton** (bulk, excluding the delivery cost); **320-330$/ton** for retail
- Applying straw compost for rice and vegetables

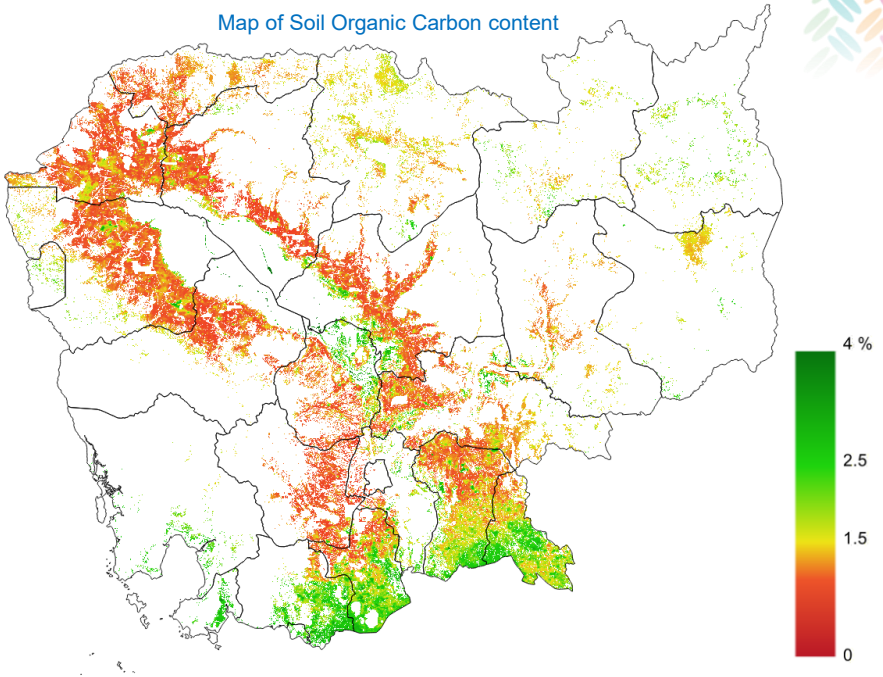




How much straw should be returned to improve soil fertility?



Soil types of Cambodia (DALRM, 2022)



68% of rice lands of Cambodia have low Soil Organic Carbon content (SOC <=1.5%) (SoilGrid data, 2021)

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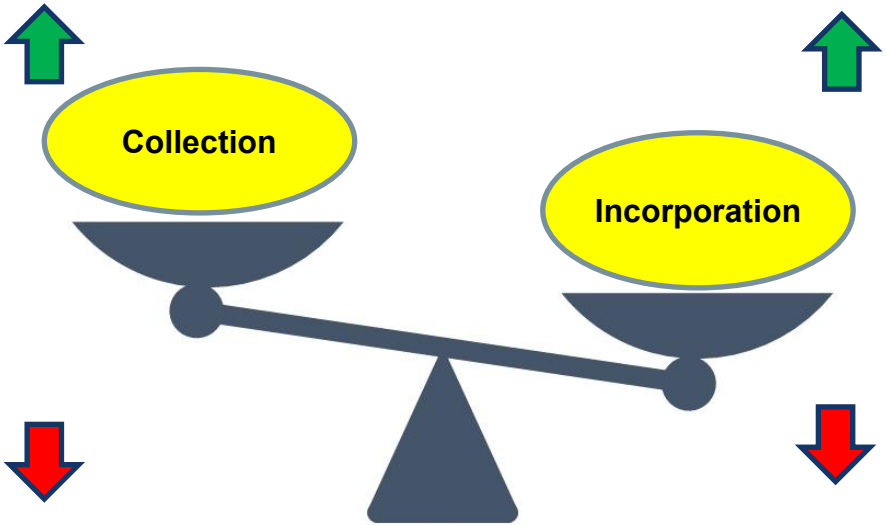
What are the BEST straw management practices for Cambodia?

- Income opportunities
- Facilitates field operation
- Avoid burning

- Returns carbon and nutrients
- Improves soil productivity
- Sustainable production



Balanced approaches:

- Identify appropriate % of straw to be collected and incorporated by agro-ecological zone, considering economical and environmental impacts
- Consider integration of straw incorporation and water management (AWD) to reduce CH4 emission

- Removes nutrients
- Soil degradation
- Increases dependence on chemical fertilizers

- Increase CH4 emissions
- Difficult field preparation
- Pest and disease risk

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Thank you!