IRRI Interventions on rice straw management for sustainable rice production

Presented by
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UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

CSAM

International Rice Research Institute

Our Mission:
To reduce poverty and hunger, improve the health of rice farmers and consumers, and ensure environmental sustainability through collaborative research, partnerships, and the strengthening of national agricultural research and extension systems.

1000 Employees, 100 International Staff

Research station: Los Baños, Philippines
17 country offices: Bangladesh, Cambodia, India, Indonesia, Lao, Myanmar, Thailand, Vietnam, Africa program in 3 countries
250 ha Experiment Station

Why rice straw management now is more concerned?

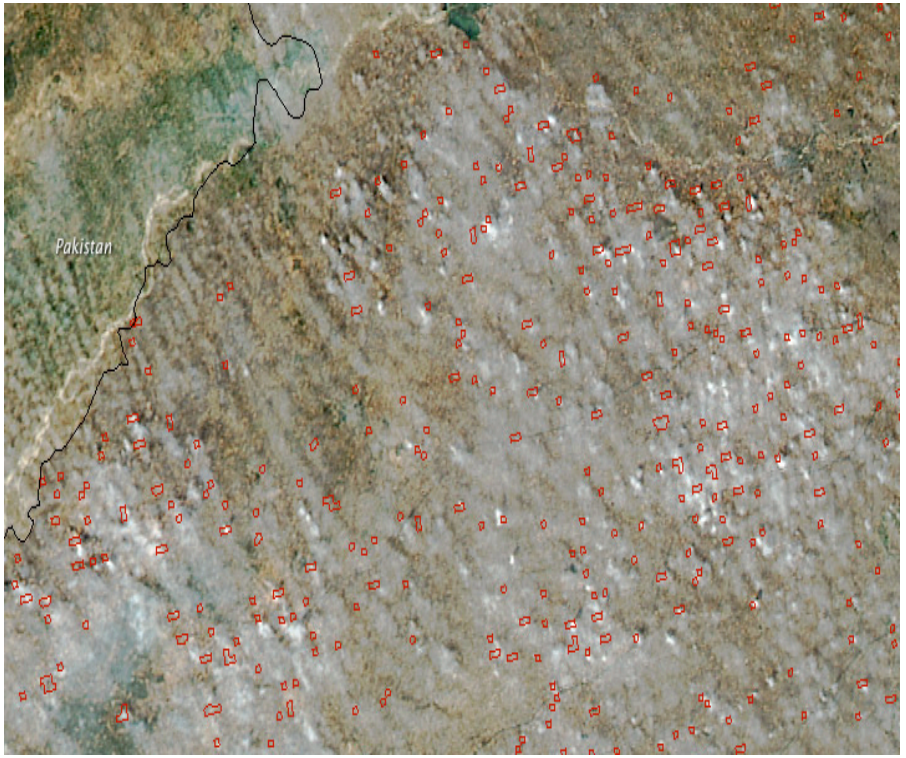
Combine harvesting as a game changer

Previous harvesting system

Some provinces in Cambodia and Vietnam now completely combine harvested

- Spread by combine harvesters in the field
- Bulky (loose form: 70-80 kg/m^3)
- Intensive labor during harvesting

Asia: around 60% (300m tonnes/year) of rice straw burnt in the field for disposal



Images: NASA / Earth Observatory
:Punjab, India

What should we do with rice straw?

Burn?

Incorporate?

Collect/ remove?

Components	N	P_2O_5	K_2O
Content, %dm	0.5-0.8	0.2-0.3	1.4-2
kg/ ton straw	5-8	1.6-2.7	14-20
Lost during burning (%)	100	25	20

for what and how?

Processing and utilization routes of rice straw (IRRI-BMZ rice straw project)

Rice production

Harvesting

In-field options

Burning

Mulching

Incorporation

Collection, handling, and transportation

Off-field options

Pre-processing

- Leaching
- Drying and storage
- Chopping
- Densification (whole bale compaction, briquetting and pelletizing)
- Ensilaging

Required depending on processing

Agricultural uses

- Carbonization (Bio-char)
- Composting
- field
- Mushroom
- residue
- Livestock (bedding, fodder)
- Waste

Energy

- Thermal (combustion, gasification, pyrolysis)
- Bio-chemical: AD, Fermentation, etc.
- Heat, electric power, syngas
- Biogas, ethanol, hydrogen, etc.

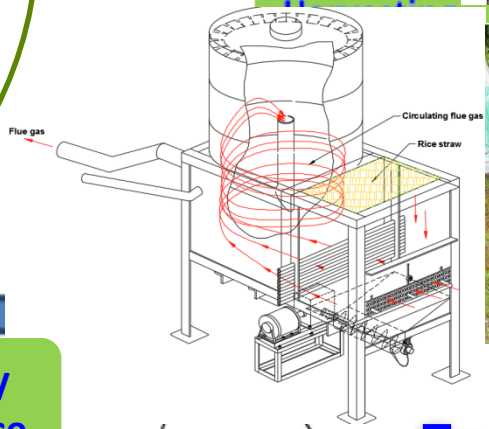
Industrial uses

- Building materials (fiber board, brick, etc.)
- Hi-end materials (silica, biofiber)

Life cycle assessments ➔ identify better, more sustainable practices

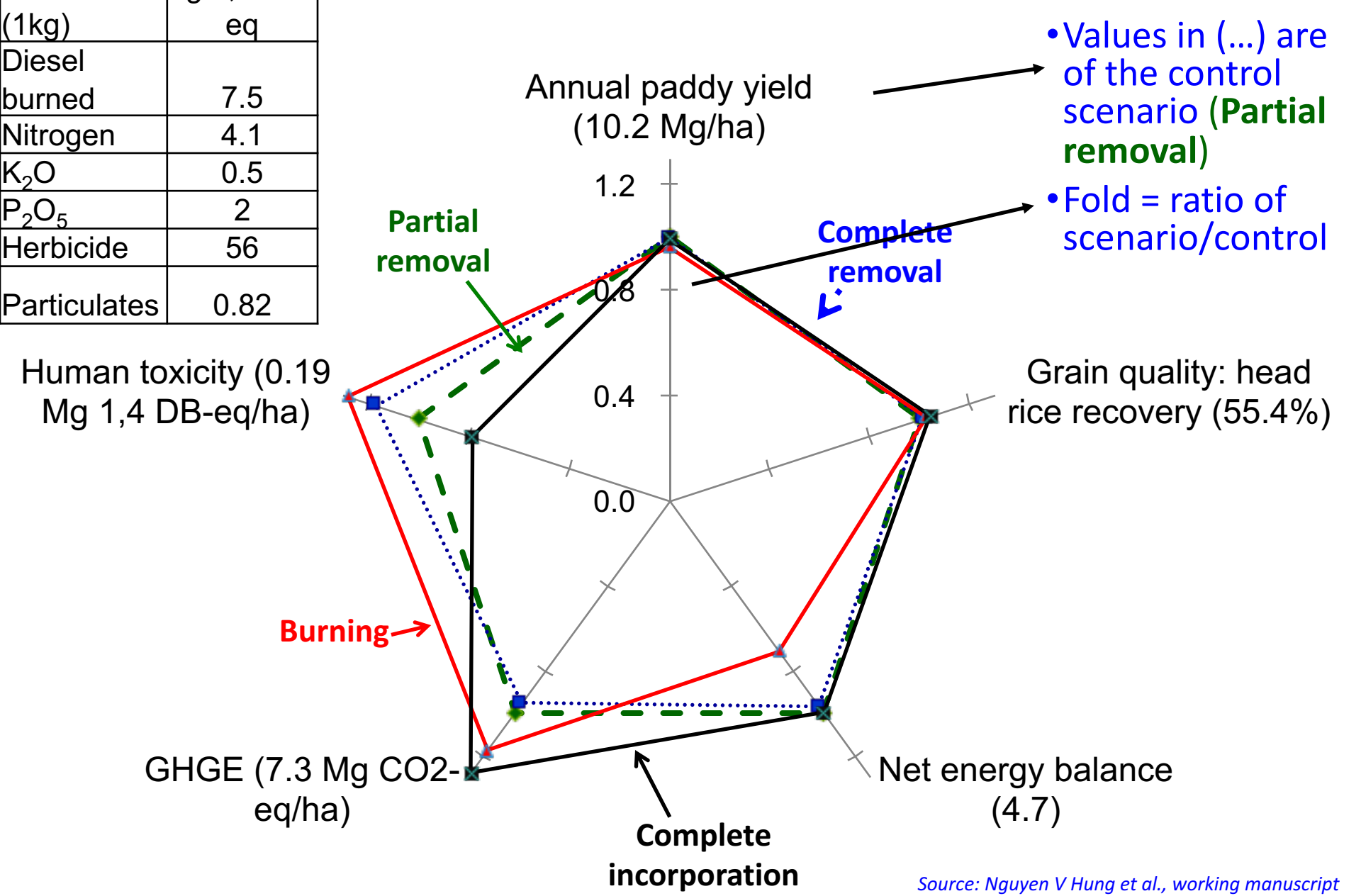
What we are doing?

Non-energy



What are the better practices?

Matters (1kg)	kg 1,4 DB-eq
Diesel burned	7.5
Nitrogen	4.1
K_2O	0.5
P_2O_5	2
Herbicide	56
Particulates	0.82



- Values in (…) are of the control scenario (**Partial removal**)
- Fold = ratio of scenario/control

Source: Nguyen V Hung et al., working manuscript

Highlighted achievements: Mechanized collection in Vietnam

First demo of rice straw collection in 2013 ➔Contest 2016 ➔ contribute to develop this practices in Vietnam ➔ 50% of rice straw in dry season now is collected **= reduce 50% burning in dry season = 2-3 million ton rice straw**

Published in: http://www.sciencedirect.com/science/article/pii/S0378429016302854

Rice straw based composting

Rice straw, fruit waste, green cut, animal manual: Optimized C/N = 25-30

High demand of compost substrate for fruit-plants (e.g. dragon fruit-plant

- Machine development and field trials at IRRI (Hohenheim University and IRRI – 2017)
- Machine development, field trials, and business models in Vietnam (Nong lam University, Tien Giang University, IRRI)

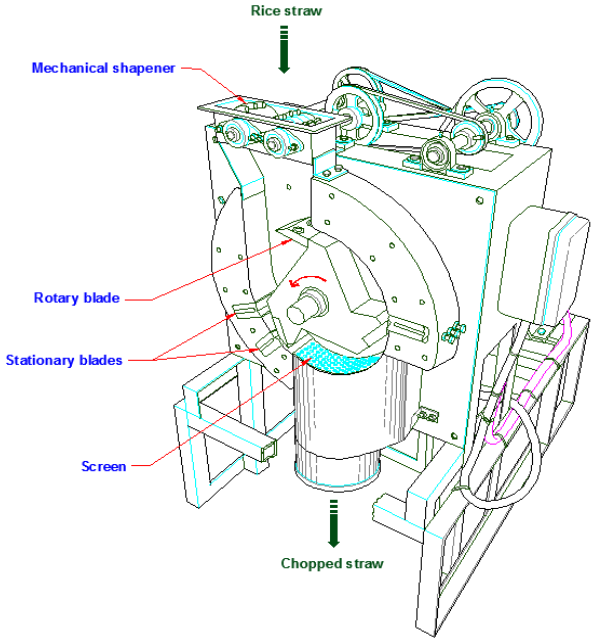
Rice straw based cattle fodder

Dry straw

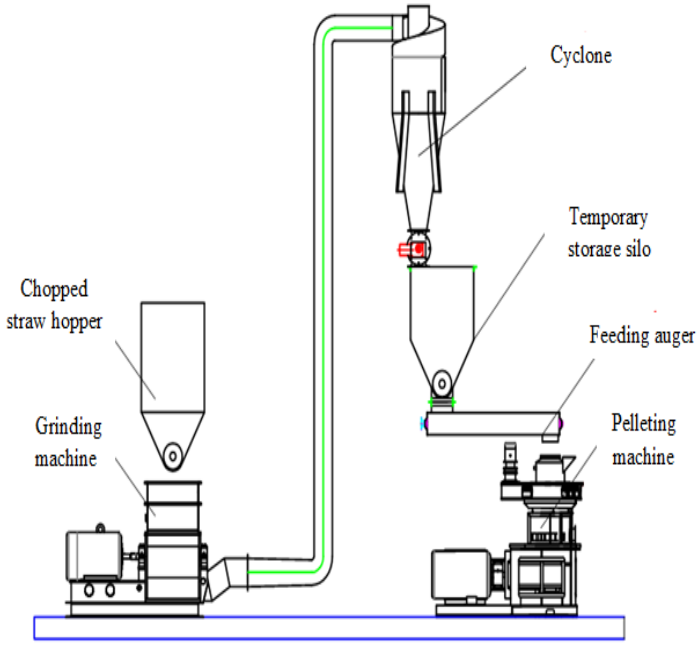
Fresh and wet straw

- Developing the technologies of rice straw silage for cattle feed based on:
  - Assessments of the actual practices in Vietnam (TH True Milk company)
  - In collaboration with ILRI
- Building the demos, and capacity building to scale out the technologies and practices

Straw chopping and pelletizing



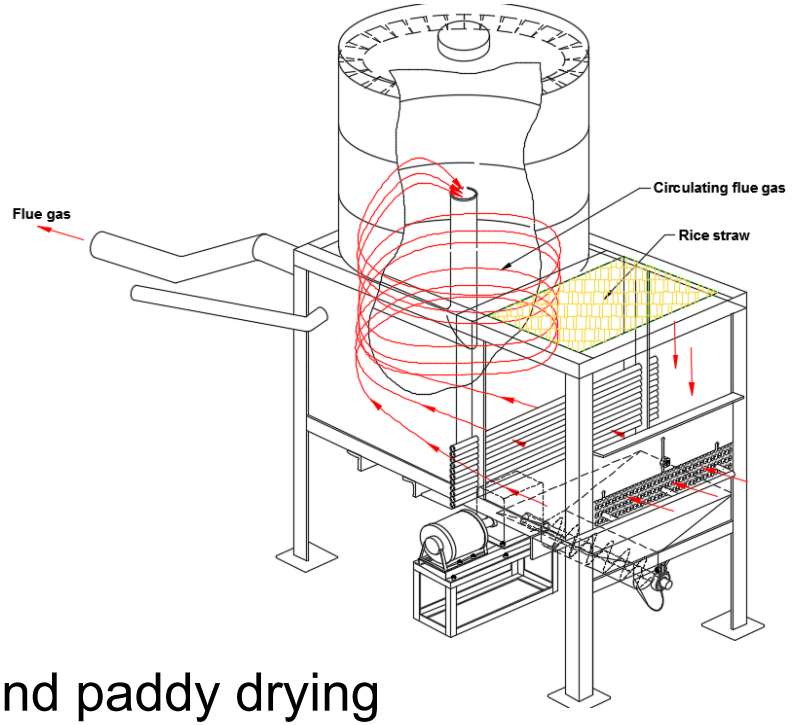
Testing ongoing



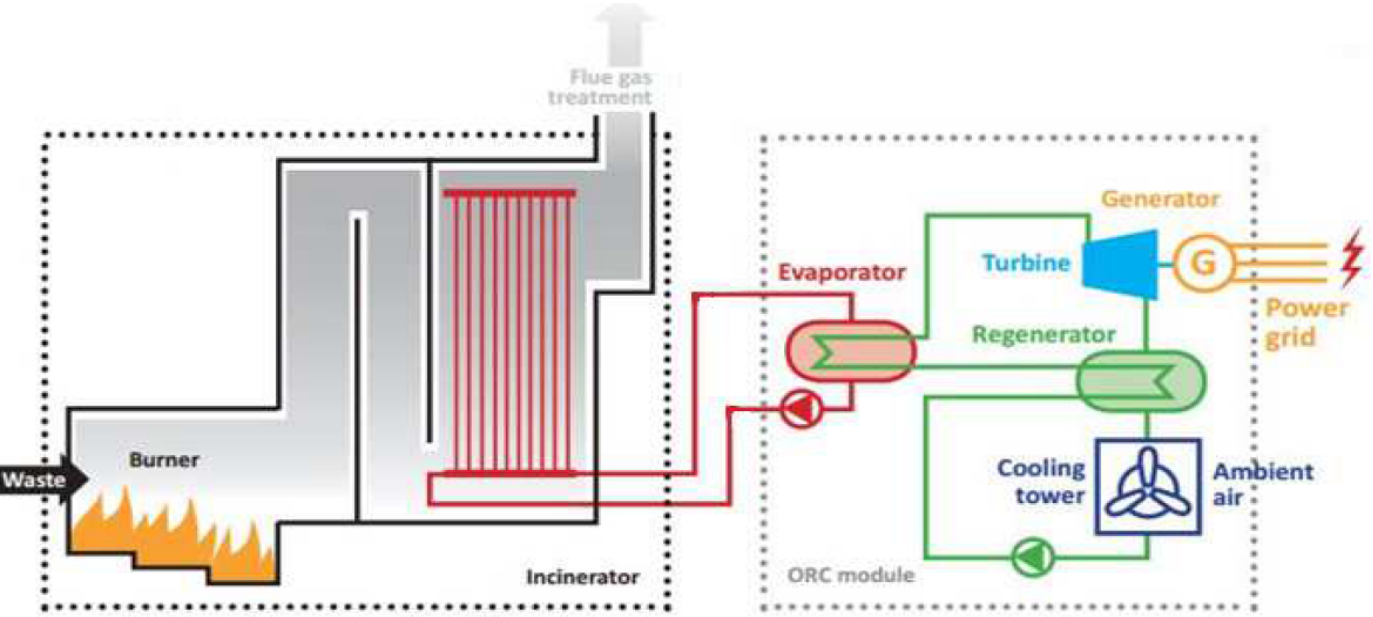
- Pelletizing cost: 21 USD/ton (for depreciation, energy, labor,…)
- Potential for energy, cattle feeds

Source: TGU, NLU-IRRI ongoing research

Energy: combustion



Cross-flow furnace for rice straw and paddy drying



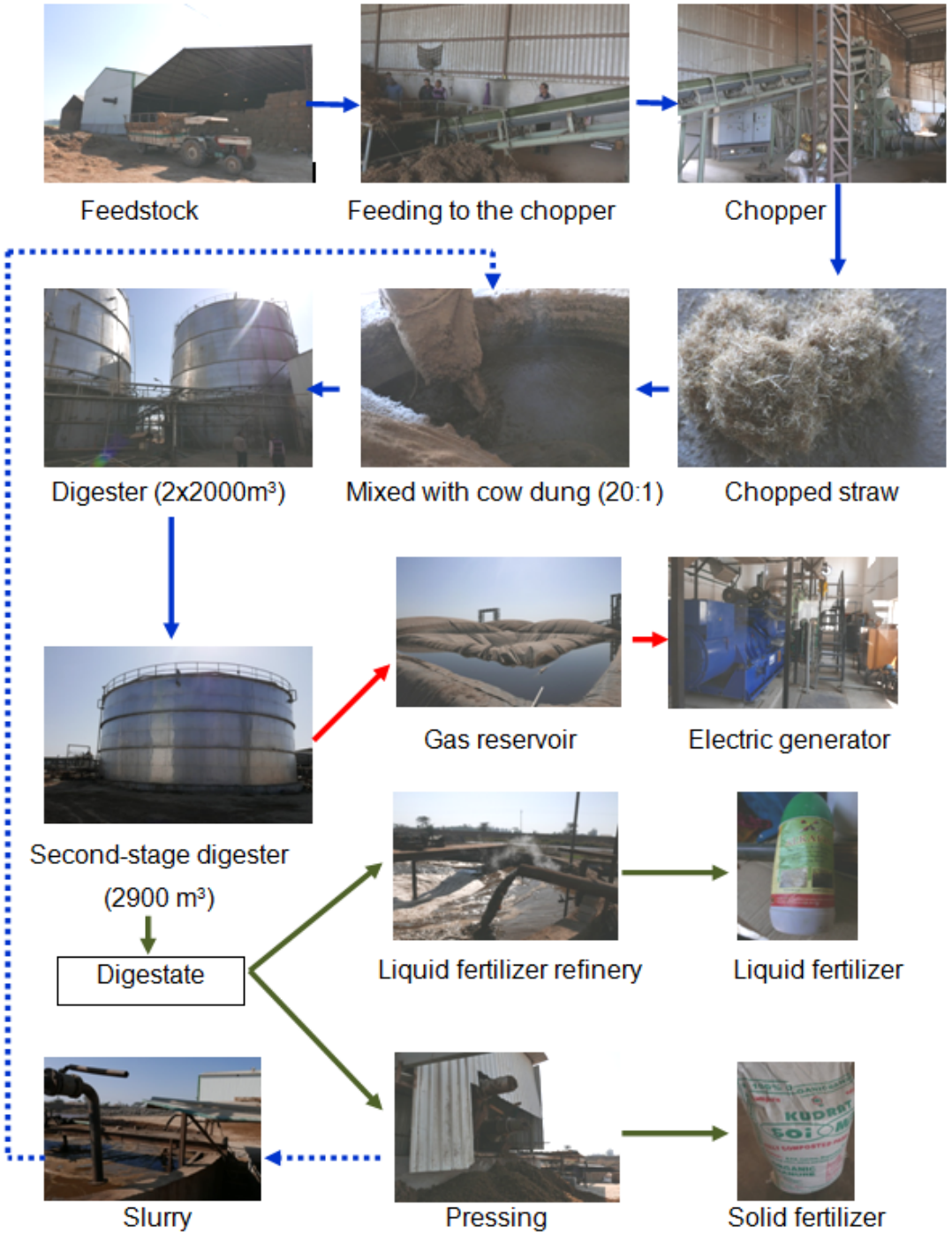
ENERTIME-IRRI project: Feasibility of 1MW power plant

Organic Ranking Cycle (ORC)

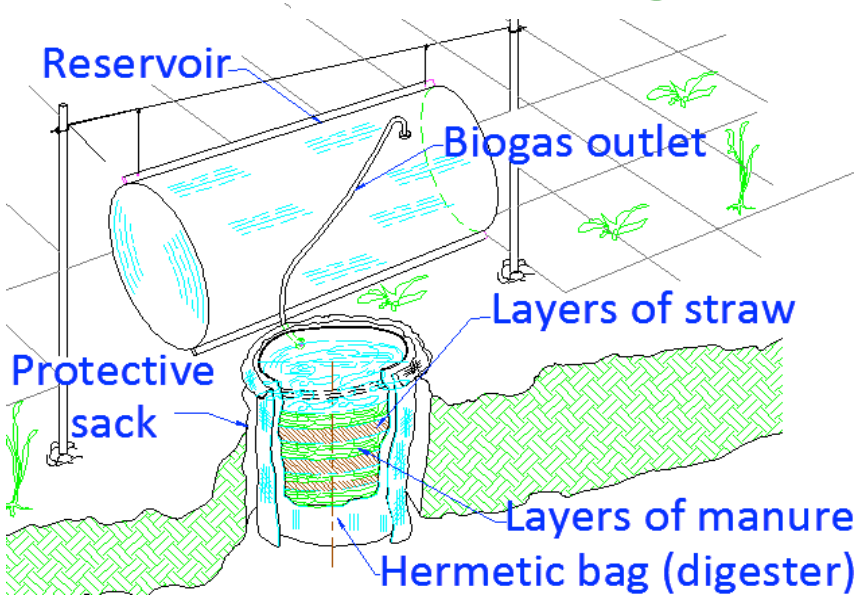
Rice straw AD power plant 1.2 MWe (assessed in India)

- 15,000 ton straw/year ➔ 18 MWh/day (Self-consumption: 3 MWh/day).
- First stage 35^{0}C, retention time (RT) 21 days.
- Second stage 35^{0}C, RT 20 days.
- Biogas yield: 400 m^3 gas/ (1 ton straw (80 %TS) + 5% cow dung (20% TS)); CH_4 concentration is 50%.

Challenges: Collection, transportation, storage, pretreatment/chopping



IRRI-designed Batch AD – hermetic bag



- Low cost
- Portable
- Residue after AD can easily be unloaded and used as fertilizer
- Energy efficiency 15-25% + fertilizer (Residential time = 100 days)

Limitations: small scale, on-going development

Published in: http://www.sciencedirect.com/science/article/pii/S235248471630018X

Example rice straw supply chain in Vietnam (sustainable alternative to avoid burning – BMZ funded project)

Rice production

Harvesting

Fabricators

Distributor

Dealers

Service / Repair

Component Suppliers

Straw — Farmers

Collection — Service providers

Compacting, storage, transport — Traders

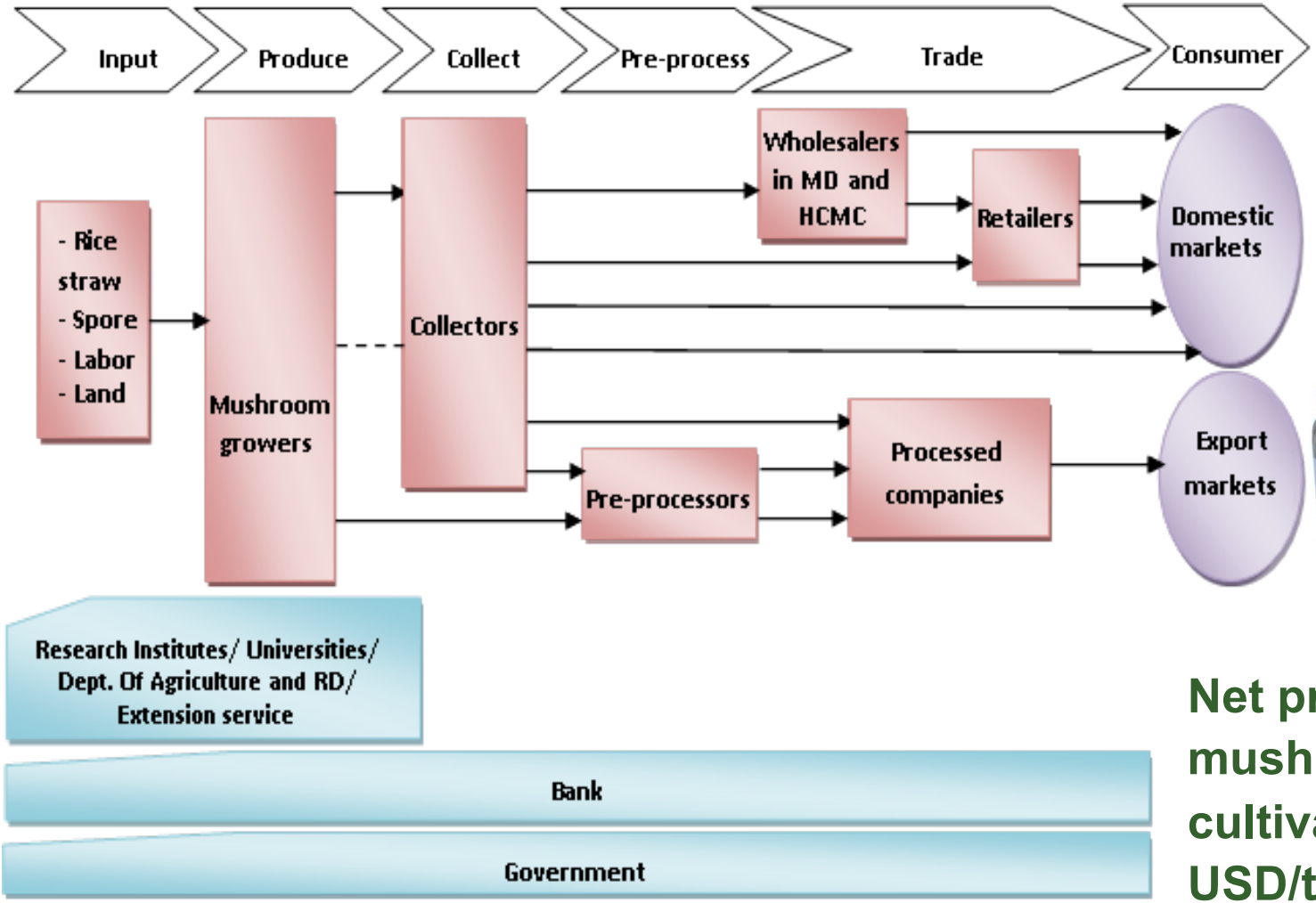
Processing — Producers

Markets (mushroom, cattle feed, etc)

Exp: Business model of collection + compacting:

Net profit 38,000 $US/year; Capital return = 1 year

Value chain of straw mushroom in the Mekong Delta



~ 60 – 70%

~ 30 – 40%

Net profit of mushroom cultivation: 50-100 USD/ton of straw used

Source: IRRI – CCAFS, Toan's master thesis and IRRI – BMZ

Summary: what can we do better for rice straw?

Negative practices

- ➔ Burn ➔ GHGE, pollutions, and nutrient losses
- ➔ Incorporate all straw: Increase 30-50% GHGE + short turn around time for decomposition ➔ causing Methane toxicity

Better practices

Partial removal

Mechanized collection, baler (net profit: 10-20 USD/ton – case in Vietnam)

- Mushroom + 50-100 USD/ton
- Cattle feed: Intake 1 kg/day/100kg live weight
  - ↑ Increase digestibility by leaching, ensilaging with Urea: needs to be developed and verified

No "one solution fits all" ➔ identify and develop **good (suitable) practices** corresponding to the specific rice production value chain/environment/market.

Our recent related rice straw publications:

Achieving sustainable cultivation of rice

Volume 2: Cultivation, pest and disease management

Edited by Professor Takuji Sasaki, Tokyo University of Agriculture, Japan

Processing rice husks and straw

Contents lists available at ScienceDirect

Agriculture, Ecosystems and Environment

GHGE

How does burning of rice straw affect CH_4 and N_2O emissions? A comparative experiment of different on-field straw management practices

Contents lists available at ScienceDirect

Field Crops Research

Rice straw collection

Energy efficiency, greenhouse gas emissions, and cost of rice straw collection in the mekong river delta of vietnam

Hung Van Nguyen [a,*], Canh Duc Nguyen [b], Tuan Van Tran [b], Hoa Duc Hau [b], Nghi Thanh Nguyen [b], Martin Gummert [a]

Renewable Energy

Available online 7 September 2017

Renewable Energy

Rice husk and rice straw furnace

Improving energy efficiency and developing an air-cooled grate for the downdraft rice husk furnace

Nguyen Van Hung [a, b], Reianne Quilloy [a], Martin Gummert [a]

Contents lists available at ScienceDirect

Energy Reports

Rice straw AD

Generating a positive energy balance from using rice straw for anaerobic digestion

V.H. Nguyen [a,*], S. Topno [a], C. Balingbing [a], V.C.N. Nguyen [b], M. Röder [c], J. Quilty [a], C. Jamieson [a], P. Thornley [c], M. Gummert [a]

more resources on *www.ricestraw.irri.org*

On-going IRRI's projects and collaborative potentials on/involving rice straw

On-going projects:

- BMZ-funded rice straw management project (Cambodia, Philippines, Vietnam – 2016- 2019)
- SDC funded CORIGAP (2014-2022)
- VnSAT (Vietnam Agri. Sustainable Transformation, 2017-2020)

Potentials:

- Rice straw Circular Economy Hub, with York University and Vietnam partners, UK-GCRF fund, targeting 2018-2020)
- Sustainable rice straw management for bioenergy, food, and feed in the Philippines (submitted proposal, targeting 2018-2019)
- Inquiry from FAO to develop rice straw project for India and Srilanca

➔Look forward to having further collaborations (e.g. Country partners + CSAM + FAO + CYMIT + IRRI + …) ➔ maximize integrated development, minimize overlap works

Thank you

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