Mechanization and postharvest management for sustainable rice production

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International Rice Research Institute (IRRI)

IRRI Research Centre in Los Baños

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
Country offices: Bangladesh, Cambodia, India, Indonesia, Lao, Myanmar, Thailand, Vietnam, Africa program in 3 countries
250 ha Experiment Station

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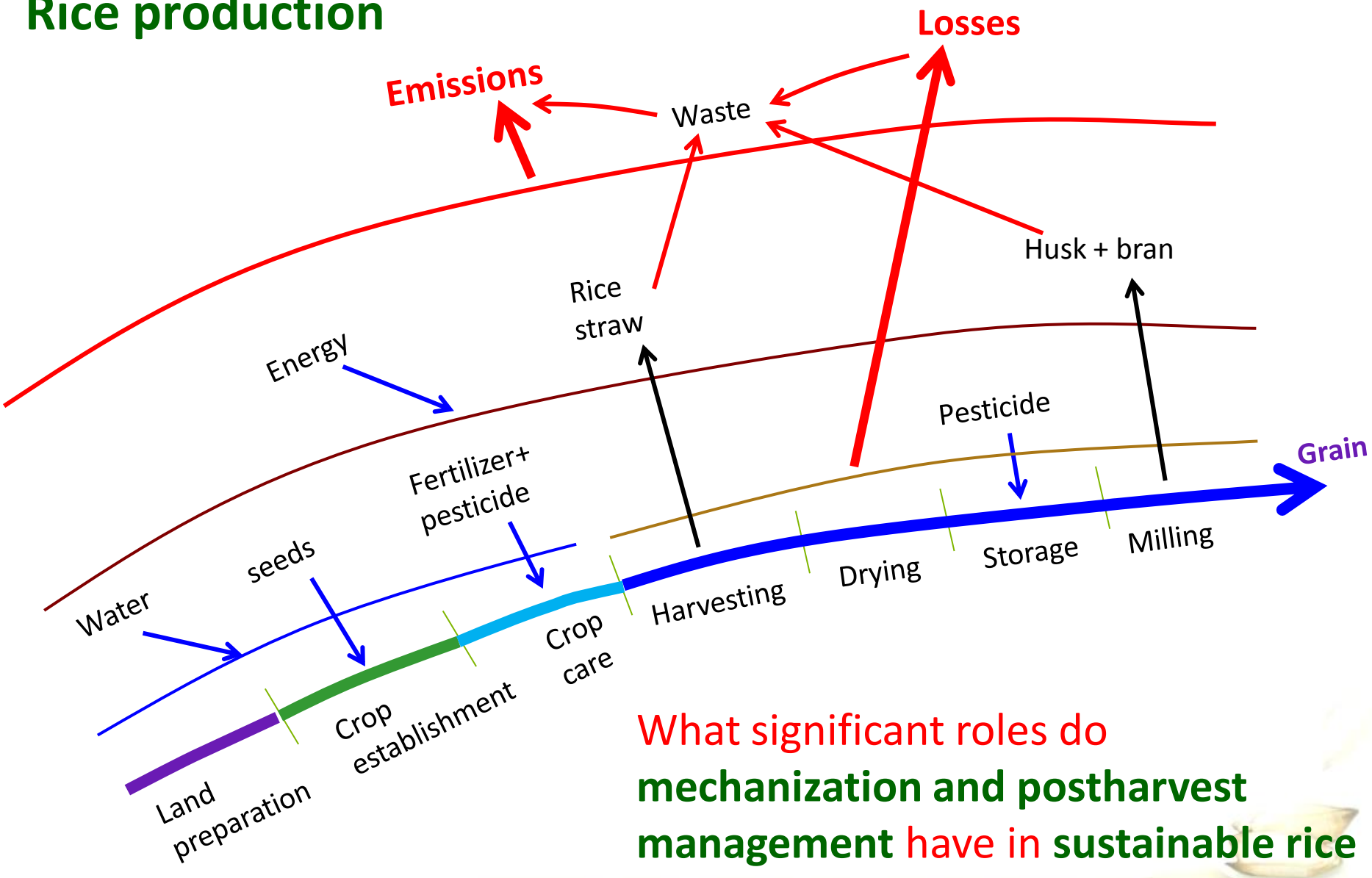
CGIAR Global Rice Science Partnership

Key points

- Problems/challenges of mechanization and postharvest for rice production
- Overview of available technologies/solutions applied and developed by IRRI
- Sustainability analysis and best practices
- Other supporting tools/factors
- Summary and recommendations

Rice production



What significant roles do **mechanization and postharvest management** have in **sustainable rice production?**

Problems/challenges

Land preparation

- Small/ fragment fields → hampering mechanization, low land use efficiency
- Unleveled fields →
  - Difficult crop establishment
  - High irrigation water requirement
  - Less effective weed control
  - More lodging → harvesting loss + lower quality
  - Uneven maturing → higher processing loss

Crop establishment and care

Manual transplanting

- Laborious
- Uneven application
- Health hazards
- Environmental hazard

Fertilizer - manual spreading

Agro chemicals
Knapsack sprayer

Harvesting issues

- Labor shortage – high harvesting cost
- Often delays because of labor shortage and unavailability of machines

➔ **losses**

Pics: Gummert, 2015

Drying and storage issues and losses

➢High losses in sun drying

➢Low quality dryer

Assume loss = 5%

≈ 15 million tons/year in Asia

≈ 7,500 million USD /year

MRD-Vietnam 2013

Myanmar 2016

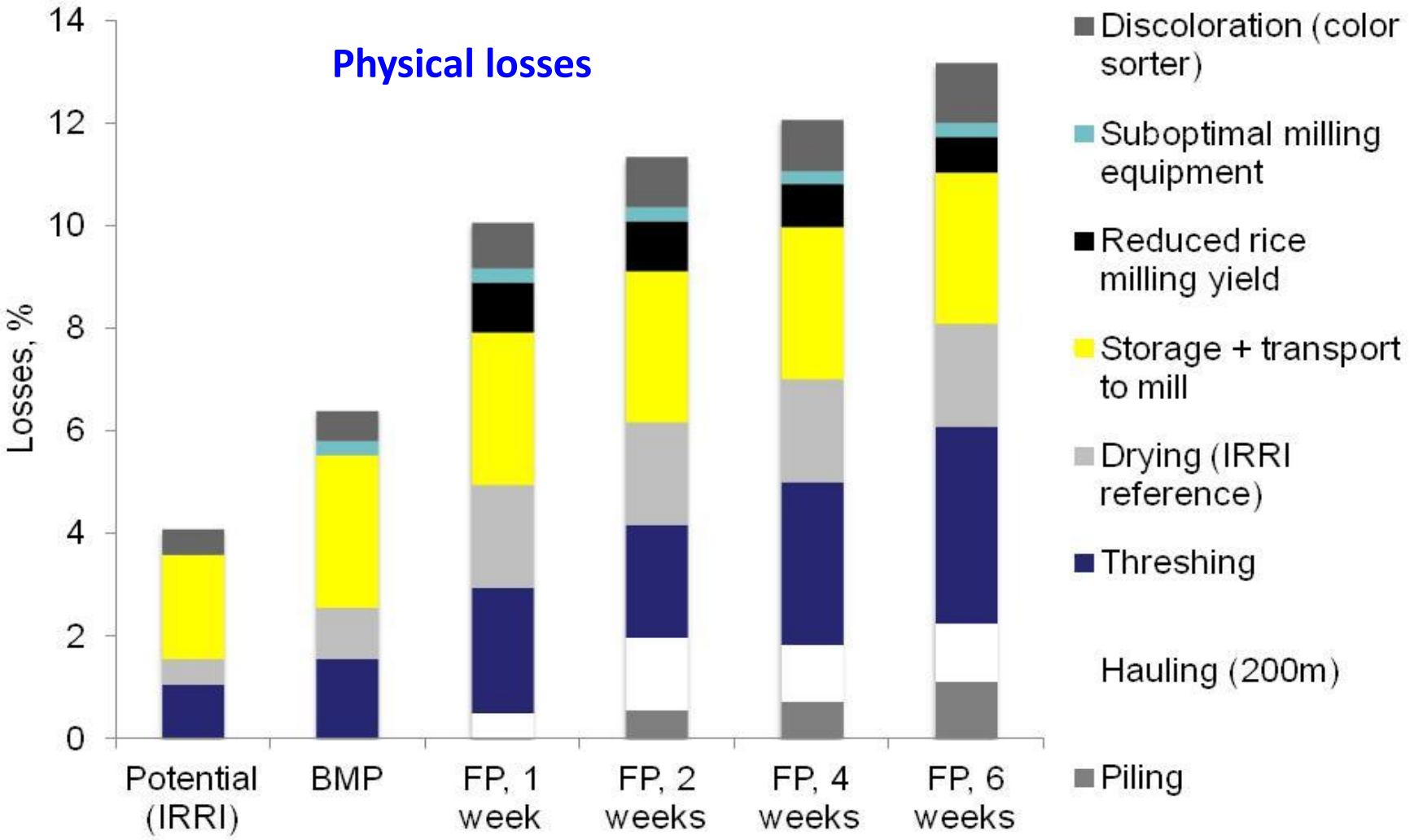
Traffic of paddy drying

➢Intensification – combine use – more crop to dry

➢Poor storage

Case study of postharvest losses in Myanmar

(ACIAR IRRI MyRice- Gummert, Wet season 2015)



Source: Gummert, 2015

- BMP: Best practice management
- FP: Farmer practices – x weeks of paddy delayed in the field

Rice straw management issues

Asia: 60% = 300 million tons rice straw is burning in the field each year

CH_4, N_2O, CO, toxic matters, etc

Problems of straw burning in Ha Noi, vnexpress.net – July 2016

Avoid burning straw – MONRE – Viet Nam (Nov 10, 2017)

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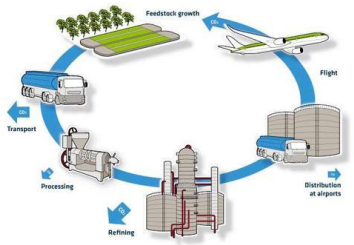
Solutions?

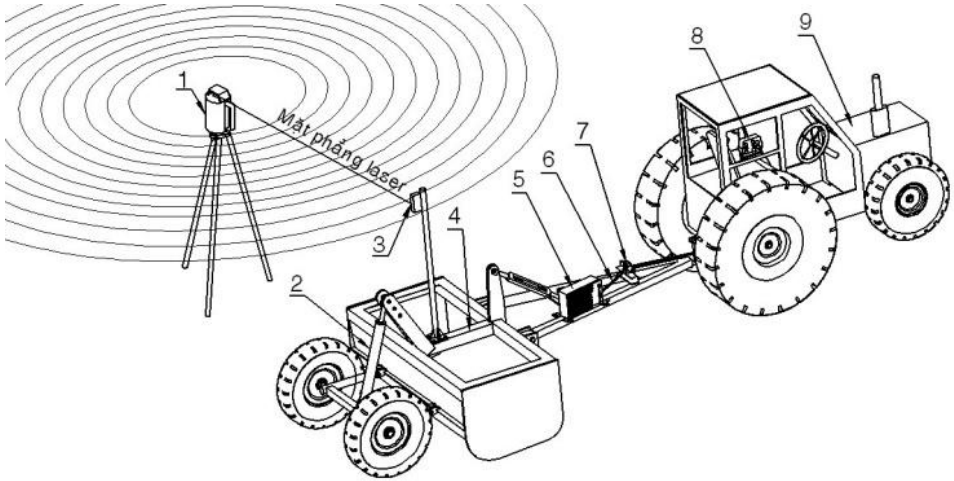
- Advanced and **sustainable technologies/solutions**
- **Best/sustainable practices fixing the specific contexts** quantified through decision making tools such as Lifecycle assessment.
- **Sustainably integrated system/value chain**
- **Supporting tools/factors** such as Private-Public-Partnership models, Learning alliance, etc.

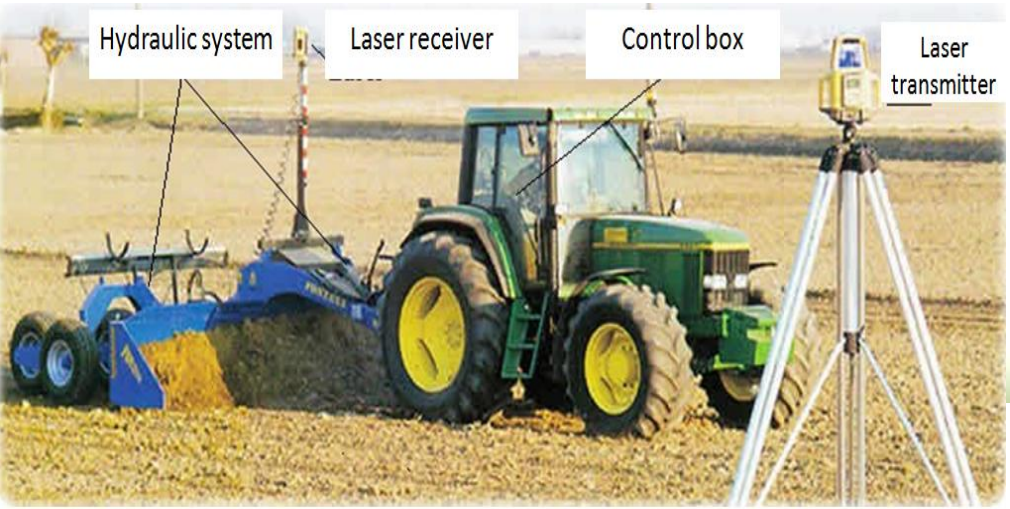


Component technologies/solutions

Laser controlled land leveling

Applying LLL for 1 ha of rice field ➔ can reduce 282 kg CO_2 eq
+ Increase yield: 5-15% + Saving water: 20-25% *(Source: IRRI)*





Crop establishment and care

Drum seeding

Precision plot seeder

Transplanter

Fertilizer spreader – cum – chemical sprayer

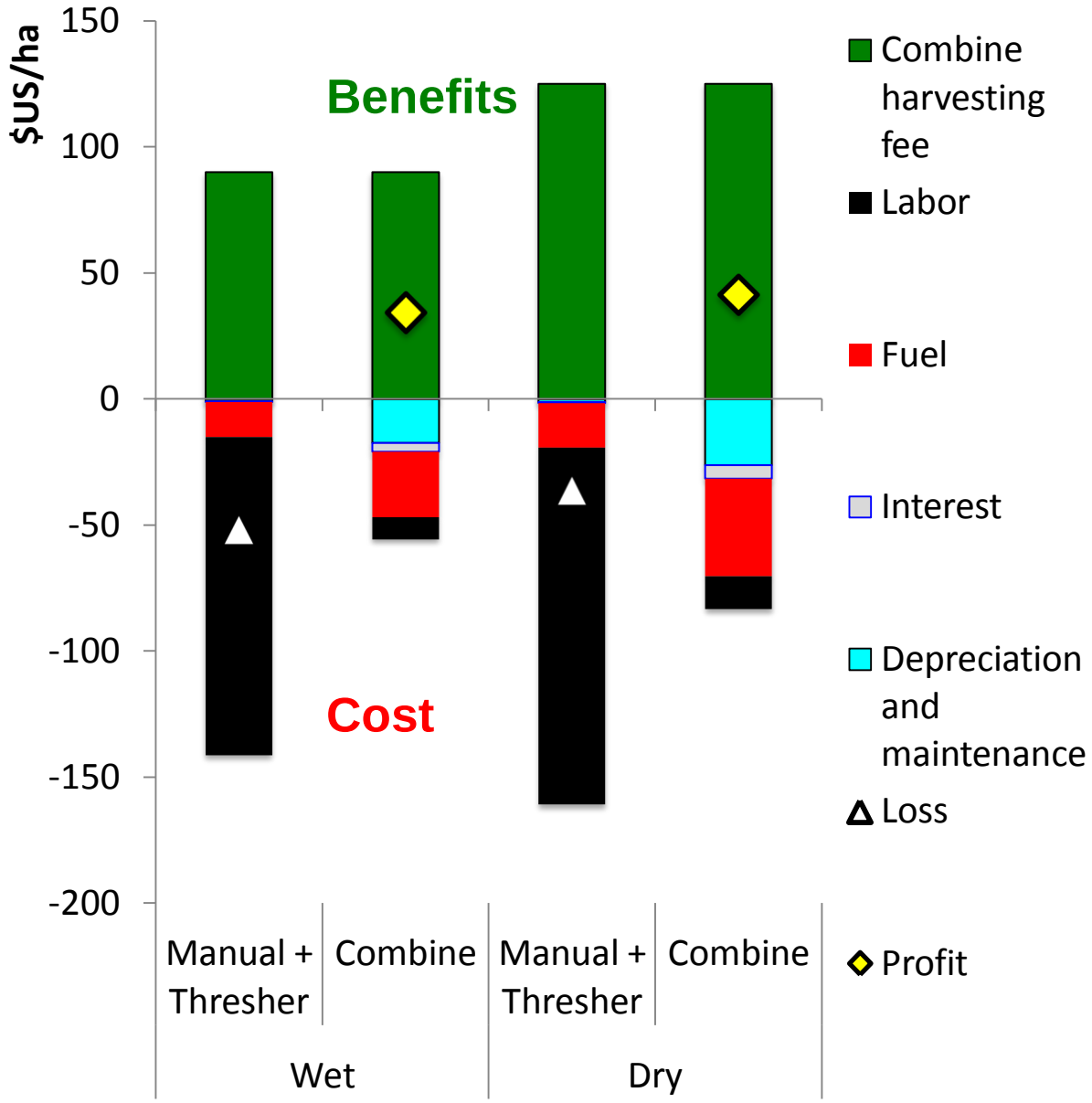
Chemical sprayer

- Time saving
- Precision and even application
- Safety and health of operator
- Options to further mechanize, auto-steering, GPS, etc

Combine harvester

- Address problem caused by labor shortage
- saving 50% harvesting cost from manual operation.
- Reduce losses to 1-3%

Vietnam: >10,000 units (2013); 90% of paddy harvested by combine



Source: Gummert et al. 2016

Drying and storage

Solar Bubble Dryer: uses only solar energy, zero emission

Flatbed dryer with rice husk furnace (NLU)

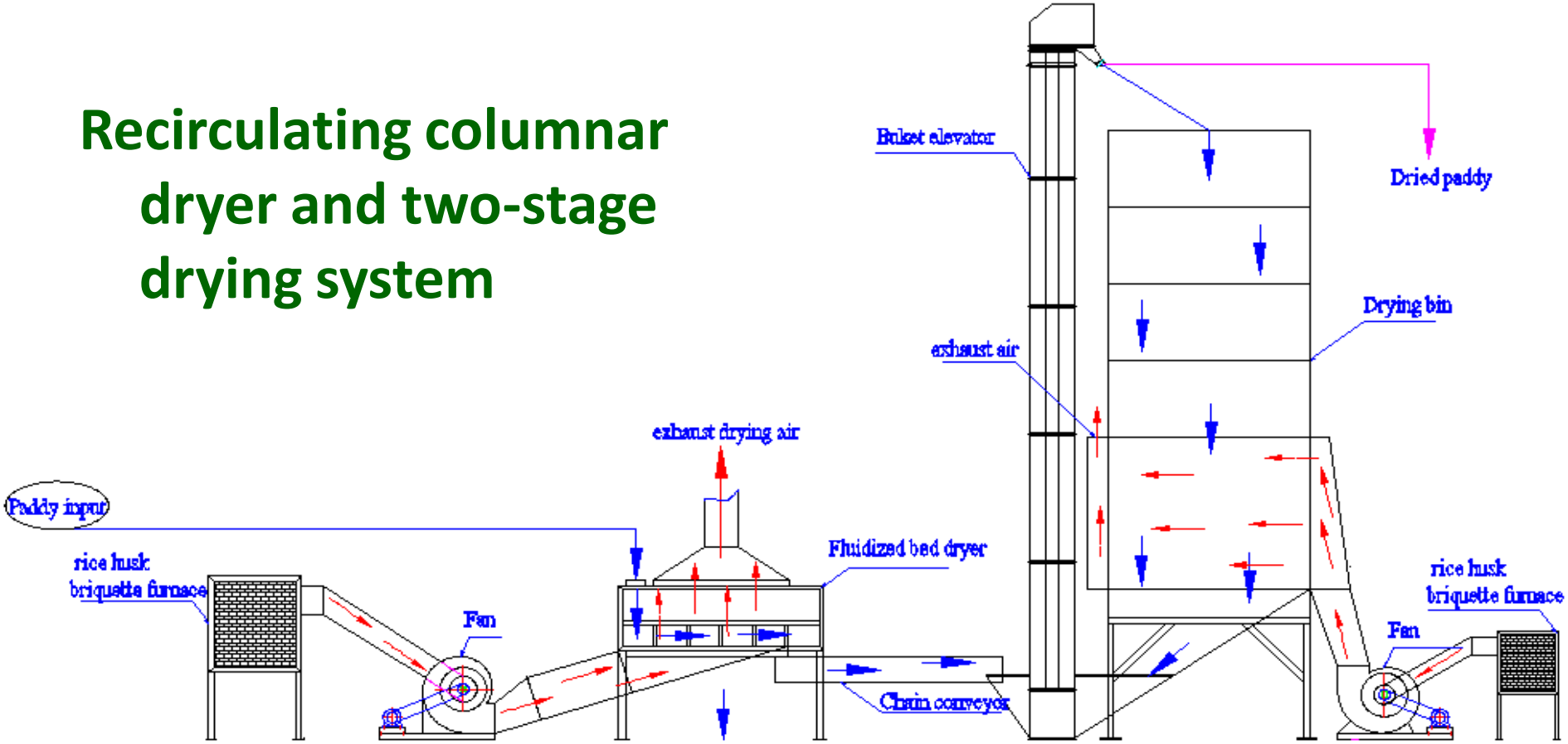
➔ Use renewable energy

➔ Reduce 2-5% loss

Hermetic Storage System

No energy consumed, no pesticide used

Recirculating columnar dryer and two-stage drying system

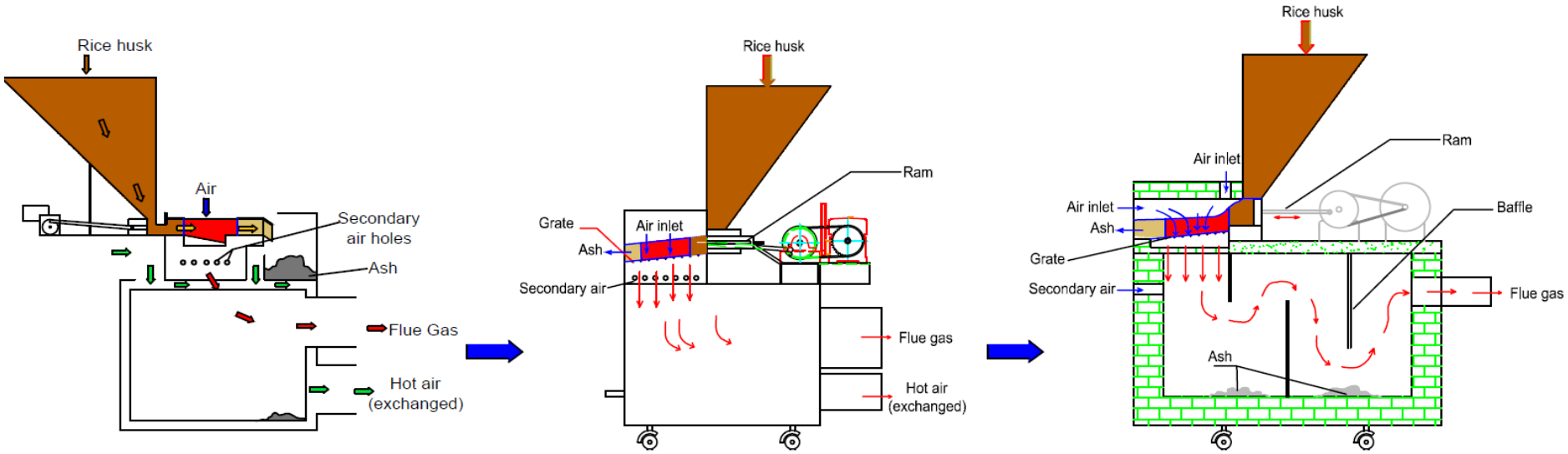


NLU-IRRI recirculating columnar dryer

Two-stage drying system in MRD (2013)

IRRI-Downdraft Rice Husk Furnace for paddy drying

Renewable energy, carbon neutral, high efficiency, low pollution

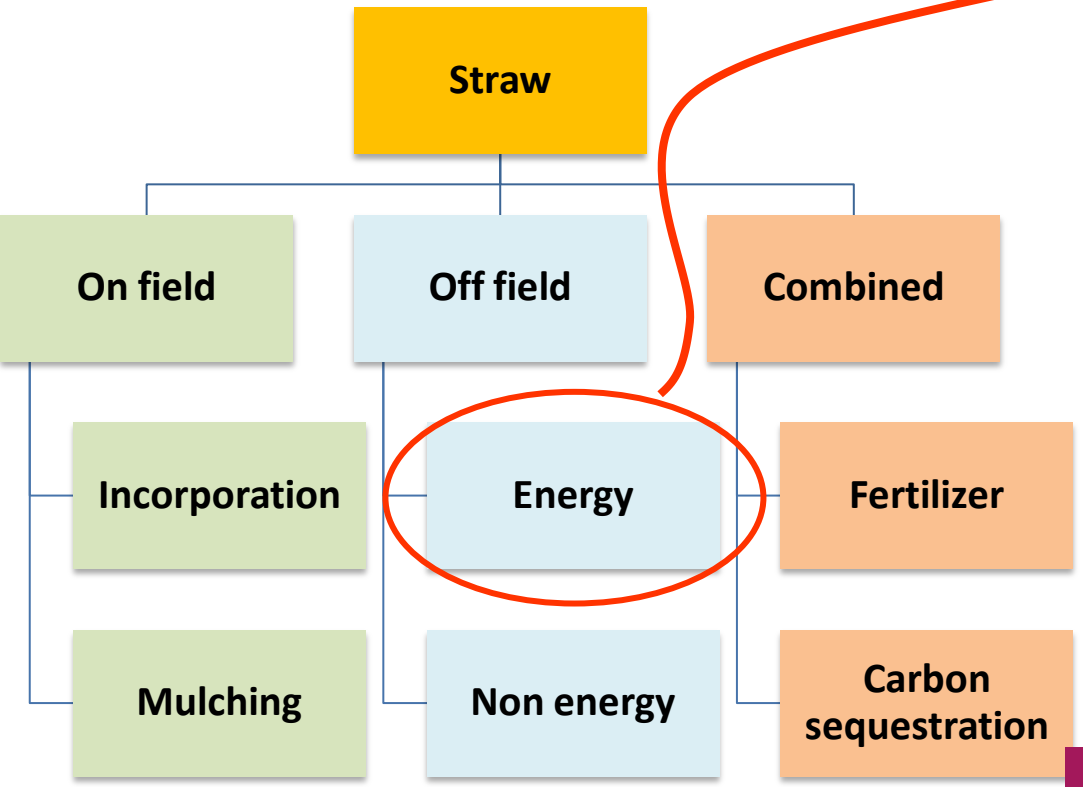


Source: IRRI-Ripple, 2015

- High efficiency (80%)
- Commercialized in the Philippines (>100 units sold as of July 2016)
- Transferred to Indonesia and Cambodia
- Improved air-cooled grate, patent application pending

Rice straw management

IRRI-BMZ funded Rice Straw Management Project (2016-2019)



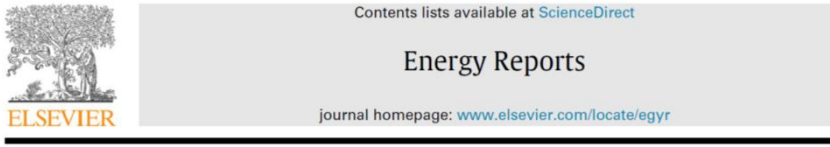
Sources: IRRI-BMZ Project, 2015; IRRI-SUPERGEN Project 2014

IRRI-SUPERGEN (UK) Rice Straw Energy Project (2013-2016)

Related publications:

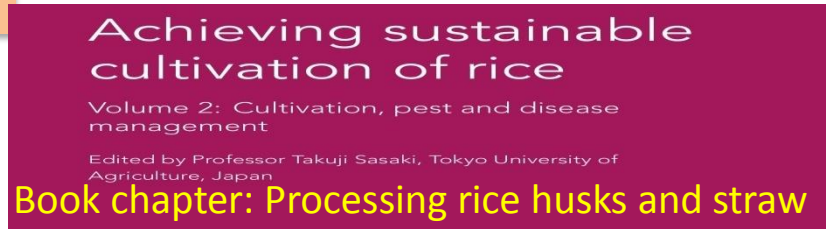
Energy efficiency, greenhouse gas emissions, and cost of rice straw collection in the mekong river delta of vietnam

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



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]



Book chapter: Processing rice husks and straw

Off-field option ➔ Straw collection

Barriers:

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

Solved in MRD of Vietnam

Demonstration in Vietnam and Cambodia, 2016
(CORIGAP & IRRI-BMZ Project)

Off-field straw management

Demonstration of straw baler in Cambodia, 2016

Demonstration of straw baler in Vietnam, 2016

Crop modeling and monitoring using drone and remote sensing system

Implemented under **IRRI-BMZ-Rice Straw Management Project**

Modelling rice crop productivity using advanced information technologies to define indicators of crop growth status for better nutrient management




Ground measurements

Advanced technologies



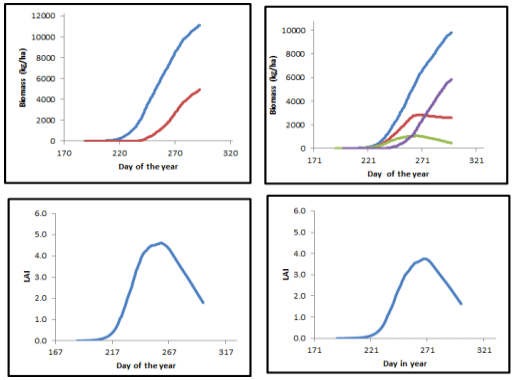

Field work: Straw management

Soil + N management

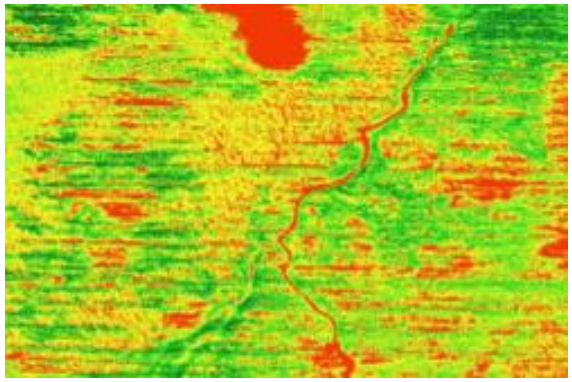
Scenarios analyses

Crop calendar

Climate change



Crop growth pattern



Crop growth signal

Source: IRRI, 2016

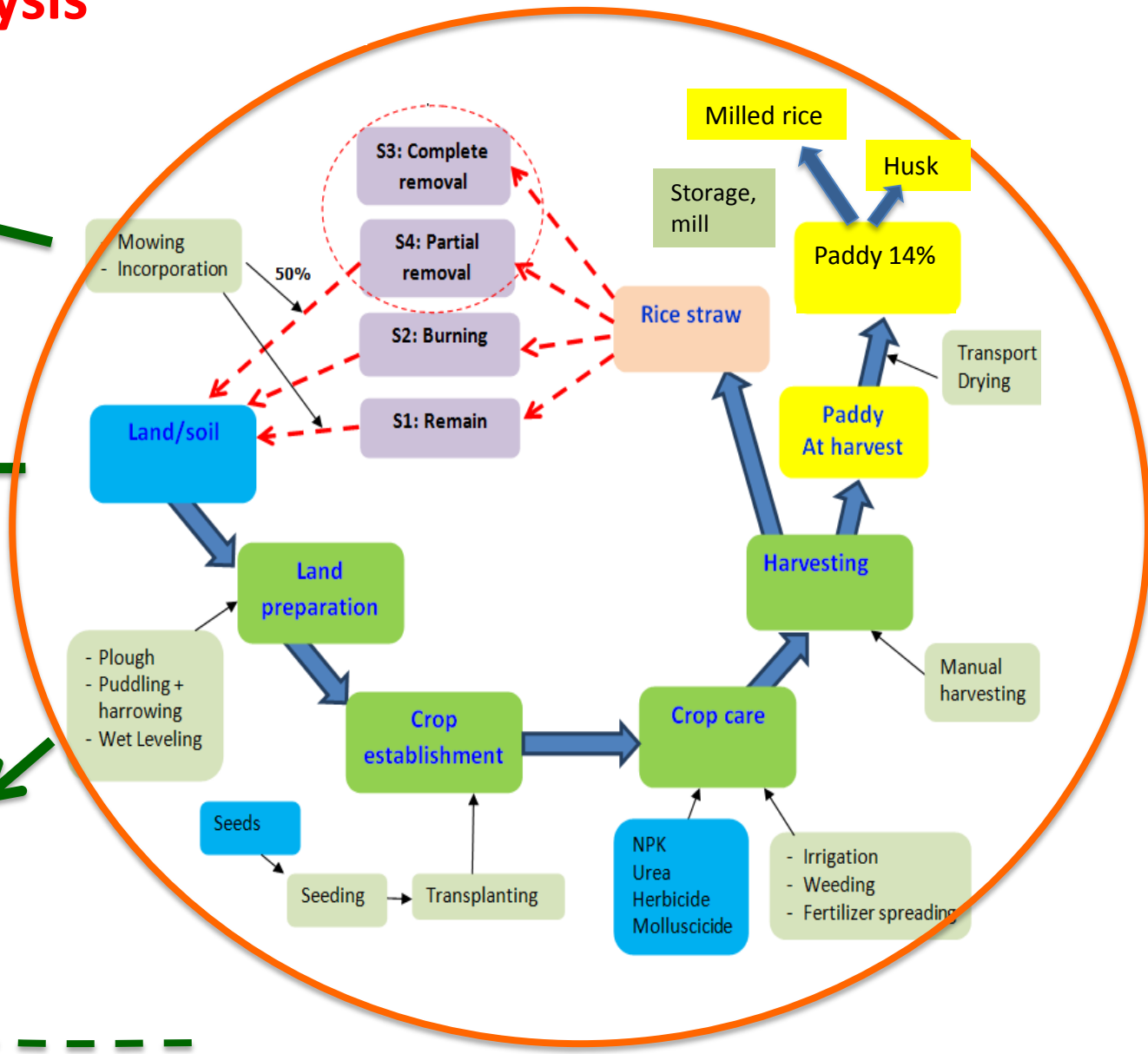
Sustainability analysis

Economic (investment, profit, ..)

Environment, energy

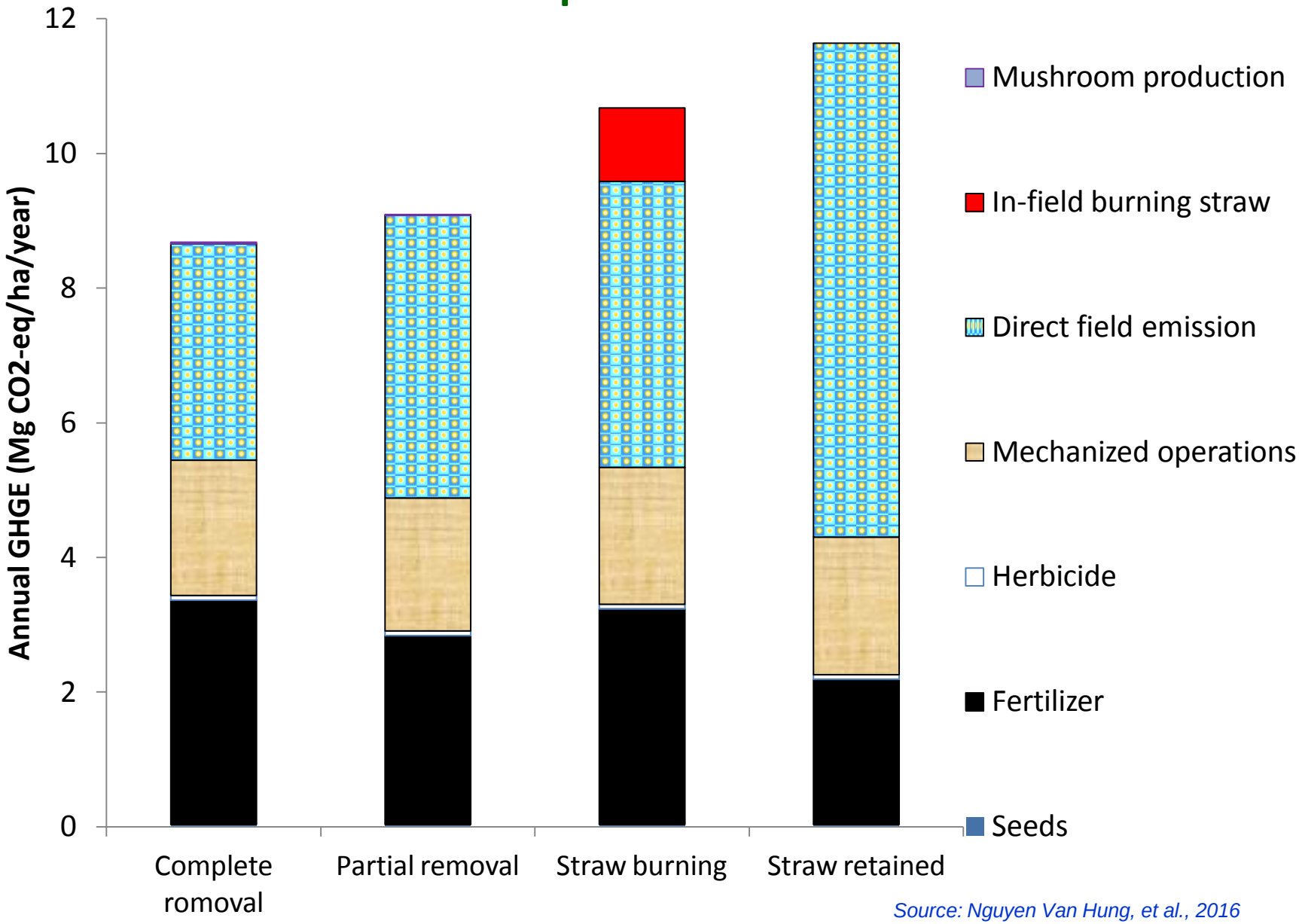
Social (livelihood, labor,..)

Quantified by



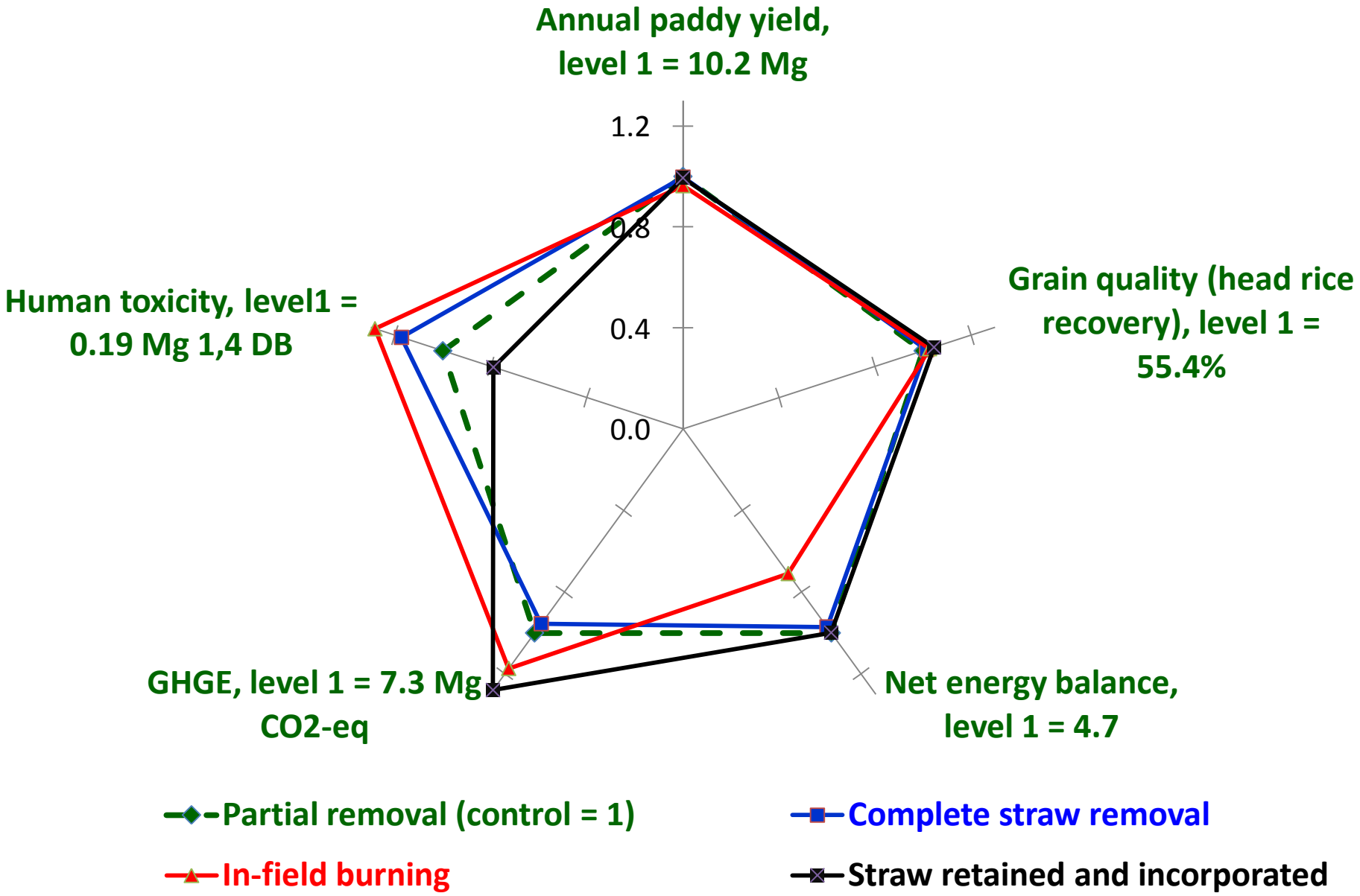
Sustainability/ Lifecycle assessment → Best practices

Case study: LCA of rice production with different straw management practices



Source: Nguyen Van Hung, et al., 2016

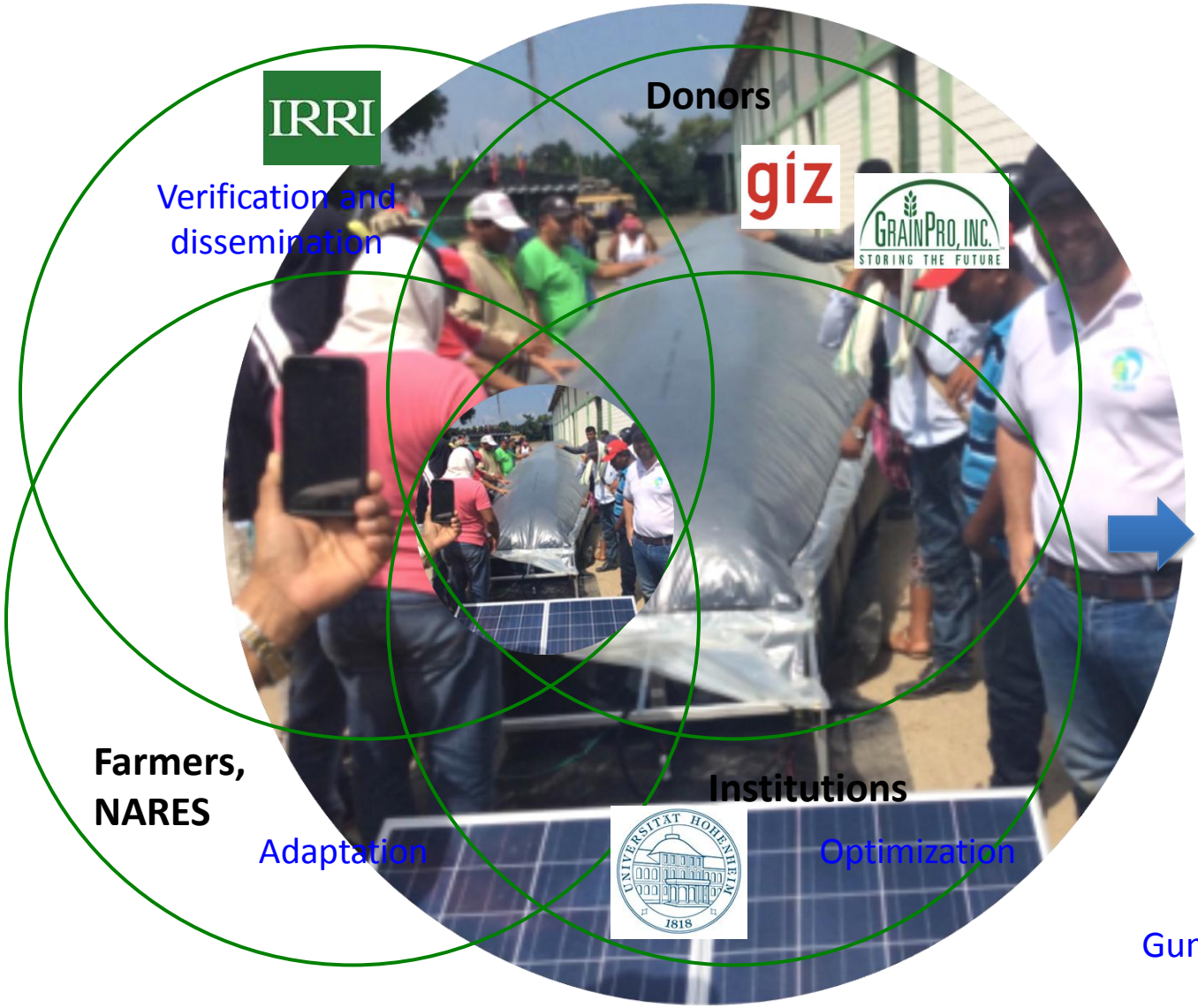
LCA of rice production with different straw management practices



Source: Nguyen V Hung et al., 2016

Supporting tools/factors

1. PPP model – Case study of IRRI solar bubble dryer



From concept to commercialization: 2 years

Gummert, GIZ – SBD project, 2015

2. Learning Alliance platform

- **Technology transfer** in NARES countries (e.g. reversible airflow dryer transferred by NLU to SEA)
- **Capacity building** of manufacturers, operators, and users on dryers and enhanced knowledge on assessing rice quality
- Developed **business models**
- **Stakeholder networks**

Source: IRRI, 2016

IRRI - Mechanization / Postharvest Projects

Learning from the past

- GIZ/IRRI/NARES - Postharvest Technologies of Rice in the Humid Tropics 1991-1997
- ADB Postharvest projects (2006-2013)
- Combine market study (2014)

Ongoing

- IRRI-CORIGAP project 2013-2020
- ACIAR-IRRI project in Myanmar: 2012-2017
- BMZ-IRRI rice straw management project
- RICE CRP (2017-2021)
  - FP3: Mechanization
  - FP2: Value chain support services and Postharvest
- Capacity building, curriculum development
  - Vocational training (e.g. Don Bosco, Cambodia)
  - Training courses at IRRI with certification

Summary and recommendations

- Trends of agricultural mechanization ➔ **sustainability**: quality and losses, energy use efficiency, environment, cost-benefits, labor-shortage, and social aspect.
- **Some advanced/mechanized-technologies for sustainable rice production:** Laser leveling, seed drills, transplanter, fertilizer spreader, combine harvester, dryers using renewable energy, hermetic storage, digital and remote sensing crop management (drones, GSM based, etc…)
- **No "one solution fits all"** ➔ strategy: identify and develop **good (suitable) practices** corresponding to the specific rice production value chain/context.
- Looking at the **whole value chain**, not just on single technology component.
- PPP, LA, joint-research platform, capacity building

IRRI joint-research group: Climate change – agronomy – mechanization - sustainability

Thank you

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IRRI Rice Knowledge Bank: http://www.knowledgebank.irri.org/
Other related information: http://postharvestla.irri.org/