Mechanization, Testing and Certification at IRRI

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IRRI

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Contents

I. Mechanization backgrounder

II. Testing and certification rationale

III. Losses in postharvest value chain

IV. IRRI's work on Testing and Certification

A. Land preparation

B. Crop establishment/crop care

C. Postharvest (e.g, drying, storage) and rice straw management

D. Training

IV. Summary

Background

Mechanization

- process or system of introducing equipment and/or machines to do work that entails ***technology***, *delivery,* and from ***seed to market*** value chain
- needs *support services* and supportive ***government policy*** to be sustainable.
- **IRRI mechanization program is over 45 years old**
  - began in 1970 with small- scale machines
  - Some mechanization highlights

Axial flow thresher
Hand tractor
Drum seeders
Laser leveling
Hydrotiller
Pumps
Combine harvesters
Dryers
Solar bubble drier

Background on IRRI mechanization

- 1990s-2000 – increased work on technology verification via NARES while continuing mechanization R&D
  - **e.g. laser assisted land leveling** and **hermetic storage**
- In 2000-2010 – new approaches for out-scaling
  - **Participatory Impact Pathway Analysis (PIPA)**, development of ***business models*** (BM) and the Postharvest Learning Alliances (LA)
- Current R&D includes:

  Solar bubble dryer, rice straw management**,** impact pathways, LA, crop establishment methods and new *public-private engagement* or PPE model

Background: Different Types of Testing

Type	Scenario	Purpose	Test Protocol	IRRI
Prototype or component testing	• Development or improvement of a machine.	• Performance, durability, compliance with regulatory framework. • Optimization of the machine or component.	Highly specific to objective	With each new technologies (e.g. SBD)
Adaptive field testing	• Testing on research farm or in farmers field.	• Testing under different cropping systems and field conditions. • Adapting technologies to local conditions.	According to objective	Most of IRRI's testing activities (e.g. laser leveling)
Operational testing	• Usually done in the field under real world conditions	• Determine machine performance and effect on crop, other factors, • Generate data for national certification of a new technology	More or less standardized, but flexible	
Certification testing	• Usually in lab on test rigs, some components in standardized fields. Checking of the data against specifications.	• Ensuring that machines comply with the regulatory framework. • Quantify performance data for end users. • Inclusion of machines in public sector programs	Standardized, part of the certification	Provide advise / support to national testing centers

Background: Types of Certification

- Certification of machinery
  - Regulatory framework
  - Performance
  - For inclusion in public sector promotion
    (danger of exclusivity, misuse to benefit some companies, promoting of equipment that farmers don't want/need)
- Certification of people
  - Trainees to become trainers (IRRI's current activities)
  - Agricultural extension
  - Operators of machinery (IRRI's current activities)
  - Manufacturers

Testing and Certification Rationale

- Need to verify suitability/adaptability of technologies/machines in local conditions
- *Developed machines have to conform to standards*
- Establish benefits to end-users in economic and financial terms
- Identify potential issues and risks in the use and adoption of certain technologies
- Enforces culture of continues improvement for **better efficiency**, improved quality, **less impact to environment**

Postharvest value chain

Ranges in PH operations in Southeast Asia

Each percent loss also means one percent inputs wasted

Physical losses in traditional postharvest chain

Cutting, handling
1-5%

Manual threshing
1-5%

Sun drying
3-5%

Open storage
5-10%

Village milling
20-30%

Small retailers

Machine threshing
1-5%

Combine harvesting
1-5%

Mechanical drying
1-2%

Sealed storage
1-2%

Commercial milling
5-10%

Large retailers

Physical losses in mechanized postharvest chain

Source: Gummert, 2013

Land Preparation

- Development and testing of laser leveling technology

➢ IRRI started to use the technology on the IRRI Farm by 1996 (initially for wet leveling)

➢ 1996-1997: IRRI designed drag bucket; Spectra Precision provided equipment

Benefits of land leveling

Level land improves water coverage that:

- Water saving: ~ 20-25% in India*, 20-40 % in Vietnam [+]
- Higher agronomic efficiency of nitrogen: 10-13%*
- Fuel savings for pumping: ~ 20%*
- Area increase due to field consolidation: ~ 5% in India*, 3-6% in Vietnam[+]
- Yield increases: 5-15% *[+]
- Higher head rice recovery: 2% increase in Vietnam[+]

→ increases both grain quality and yields

Sources: * CYMMIT, # IRRI Ag. Engineering Unit, +IRRC

Crop Establishment/Care

Multipurpose Seeder

- 2 prototypes – one attached to a 2WT with steering capability (Japan surplus, Kubota) and the other one is attached to an ordinary 2WT without steering capability (common tractors used by Filipino farmers)
- The MP Seeder can be used in dry direct seeding rice, maize planting (seeds and fertilizer), mungbean and other grain crops
- The MP seeder was tested in dry direct seeding of rice in Pangasinan State University, Sta. Maria (2015) and at IRRI Zeigler Experiment Station

Crop Establishment/Care

- *Sustainability Assessment of rice straw management using LCA tool* **– evaluated impact of small farm equipment**
  - ➢ energy balance
  - ➢ environmental impact

INITIAL DATA

Table 1. Fuel consumption (li/ha) during land preparation

Operations/ Treatments	Straw Retained (1,602.3m²)	Partial Straw Removal (1,718m²)	Complete Straw Removal (1,566m²)	Straw Burned (1,445.4m²)
Puddling, 2WT (10Hp diesel engine)	6.49	6.39	6.0	5.72
Harrowing, 2WT (6.5Hp gas engine)	6.15	4.14	5.18	6.82
Leveling, 2WT (6.5Hp gas engine)	1.96	1.34	1.59	1.73
Fertilizer application (late basal, 10DAT) with Polaro spreader, 5HP gas engine	0.099	0.106	.096	0.089

Source: Adapted from Hung, et al. 2015. IRRI.

Crop Establishment/Care

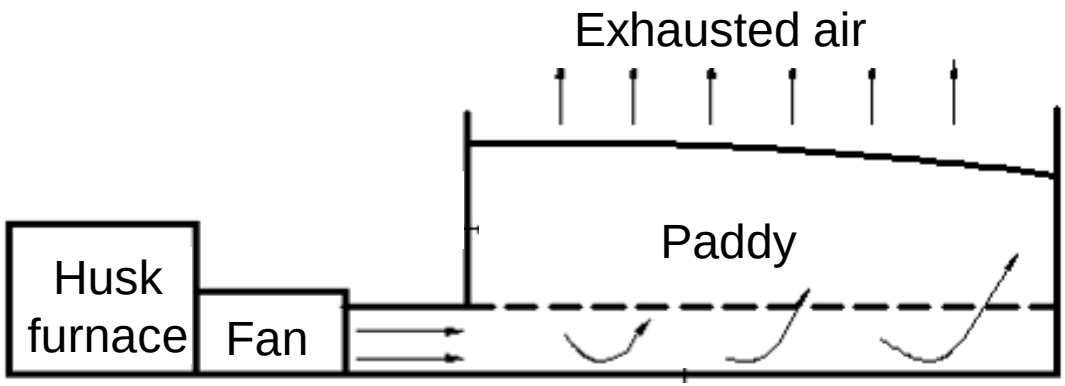
- Private company **Lehner Agrar Gmbh** donated spreader machine which is being tested for fertilizer and pesticide spraying - *comparing benefits of manual and mechanical options*

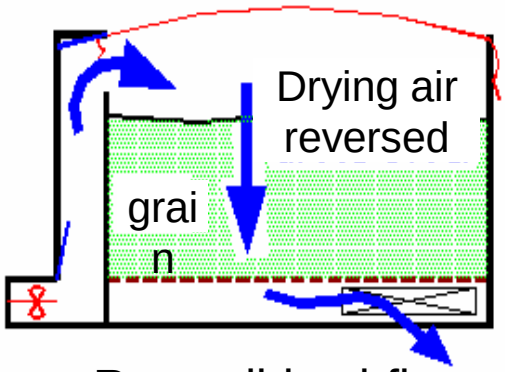
Crop Establishment/Care

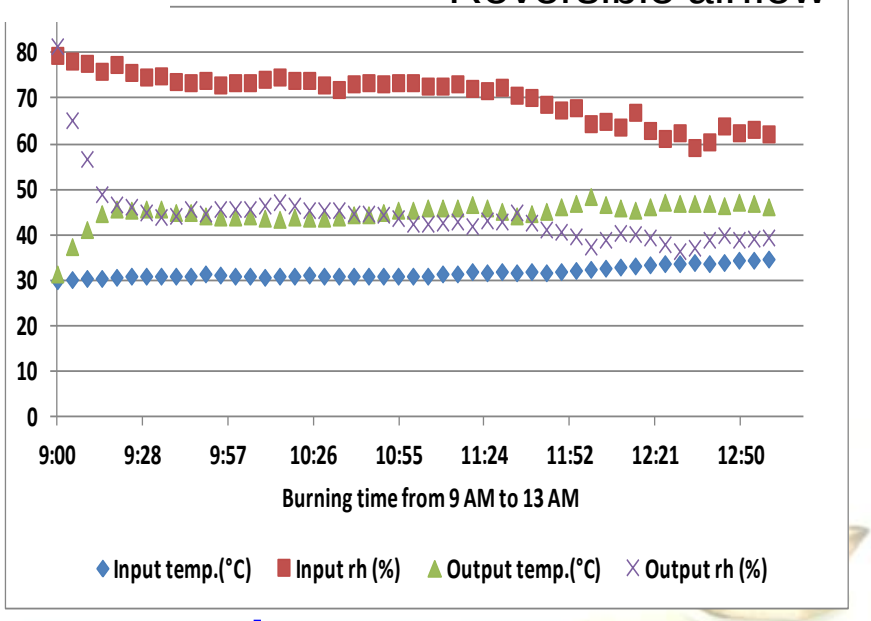
- **Adaptive experiment at farmers' fields**
  - LA platform, scaling out

The use of mechanized options for crop care (e.g., fertilizer spreading, pesticide application) is aimed at reducing labor cost, minimizing health risks, increasing efficiency and better income for the farmers.

Drying







E.g. Vietnam: started : 1990 == > 2012: 8000 units

45% wet-season crop in the MD was machine-dried ➔ reduce 2-5% loss

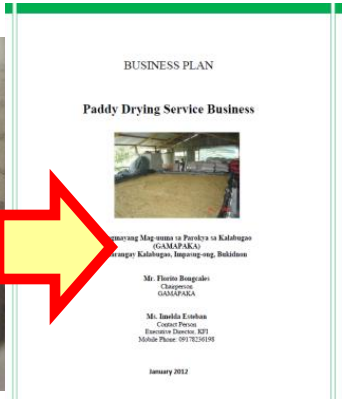
Reversible Airflow Flatbed Dryer

Transfer from Vietnam to Philippines via PhilRice

Adapted to local conditions

Demonstration and training of operators

Adopted by GAMAPAKA MPC with Catholic Relief Services



Business plan for dryer

Downdraft Rice Husk Furnace

- Carbon neutral, high efficiency, low pollution
- Commercialized in the Philippines (51 units sold as of July 2014)
- Transferred to Indonesia and Cambodia

Solar Bubble Dryer

- Development and testing in collaboration with Hohenheim University, Grainpro, Inc.
- Features
  - Inflated by using 2 blowers
  - Driven by 220V power grid or 12V solar panels
  - Better quality than sun drying

Solar Bubble Dryer, next steps

Piloting

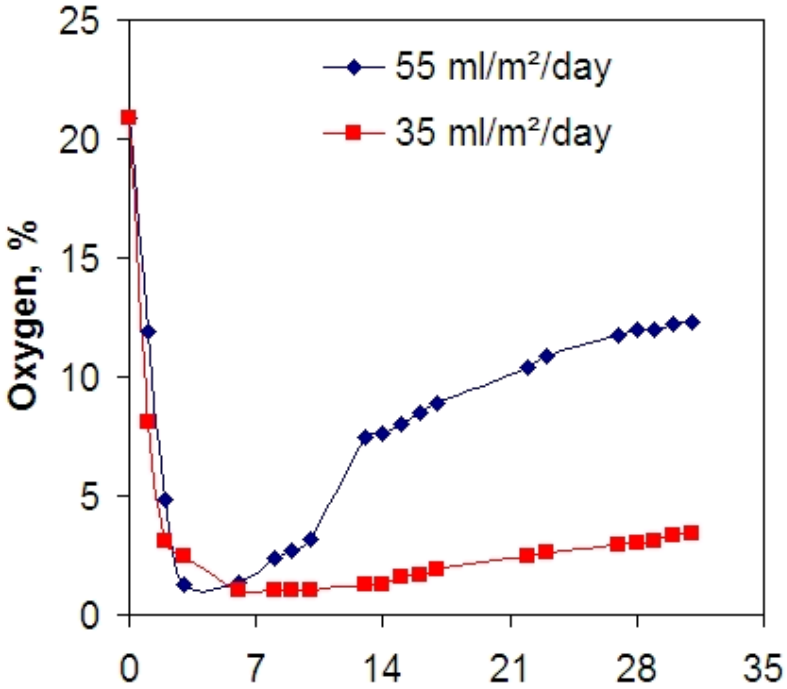
- Beta testing started in Cambodia and Myanmar
- **Agreed to test with BPTP / UNSRI in South Sumatra, and maybe at Indonesian Center for Rice Research**

Further optimization

- Larger capacity
- Reduction in power requirement
- Increase of drying temperature at low radiation

Hermetic Storage System

No energy consumed, no pesticide used



Graph showing daily drop in oxygen content in plastic bags with different oxygen permeability

Principle

- Airtight enclosure
- Biological activity reduces O_2
- Insects die or become inactive
- Plastic controls moisture

Safe storage without pesticides

Source: Gummert, 2015

Hermetic Storage: different scales

50kg bag

1t

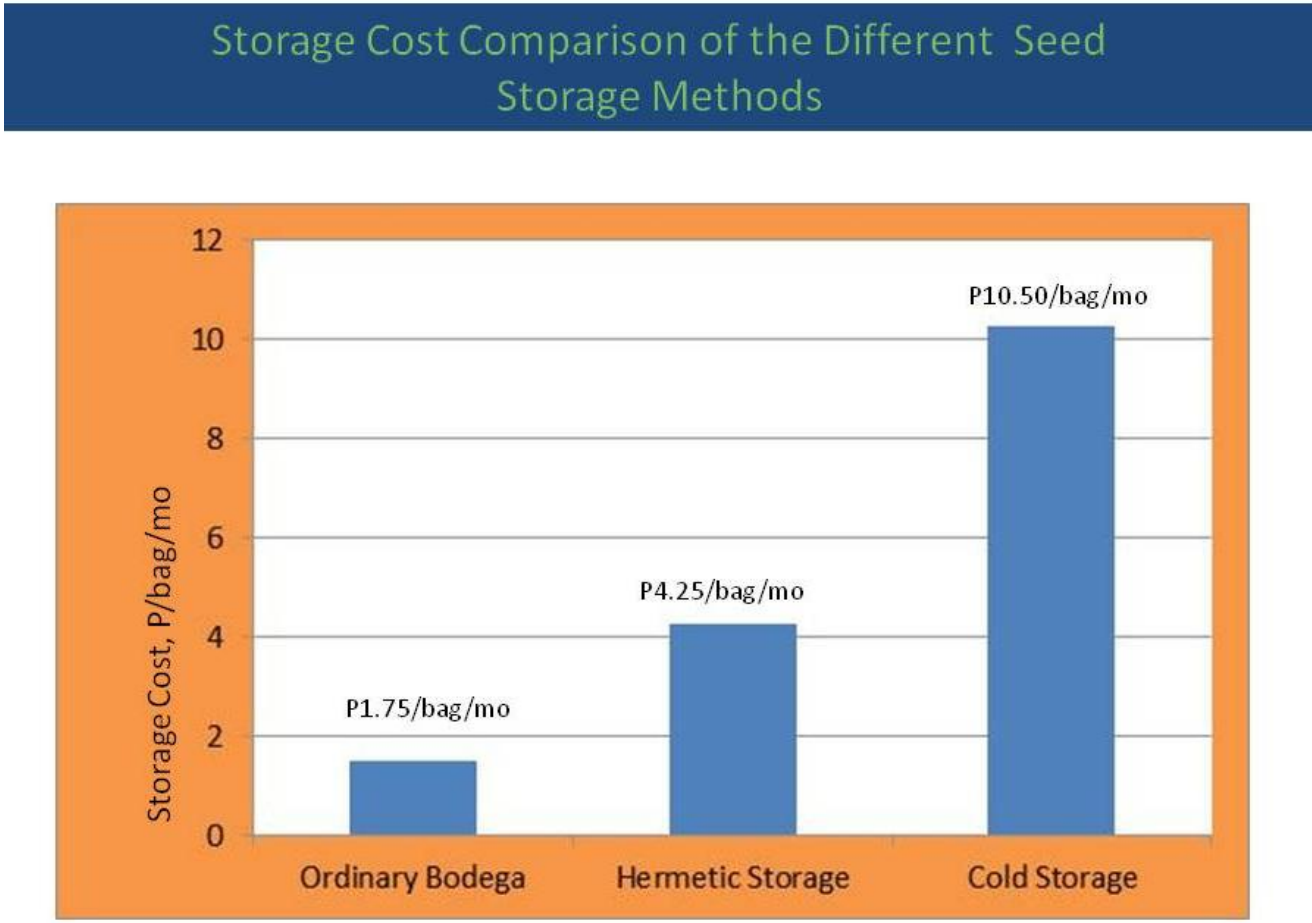
300t Cocoons in Peru
(Photo: GrainPro)

	Farm level – super bag	Farm level-GrainSafe	Industrial level-Cocoons
Capacity (kg)	3-80	1,000	$(5\text{-}1050)*10^3$
Materials	Special plastic, low oxygen permeability	PVC	PVC
Price ($US)	2-4	250	-
Tested	SEA	SEA	Myanmar, Peru

Testing and technology verification

- Testing and evaluation following standard protocols

- In collaboration with government (e.g., Philrice, PhilMech, DA-BES) private (e.g., Grainpro) institutions, and NGOs



Source: *Adapted from Yap and Marcelino, 2012. DA-Bicol Integrated Agricultural Research Center.*

Testing and technology verification

- Testing IRRI Super bag with other crops (CIMMYT)

Evaluaciones preliminares hechas en CIMMYT

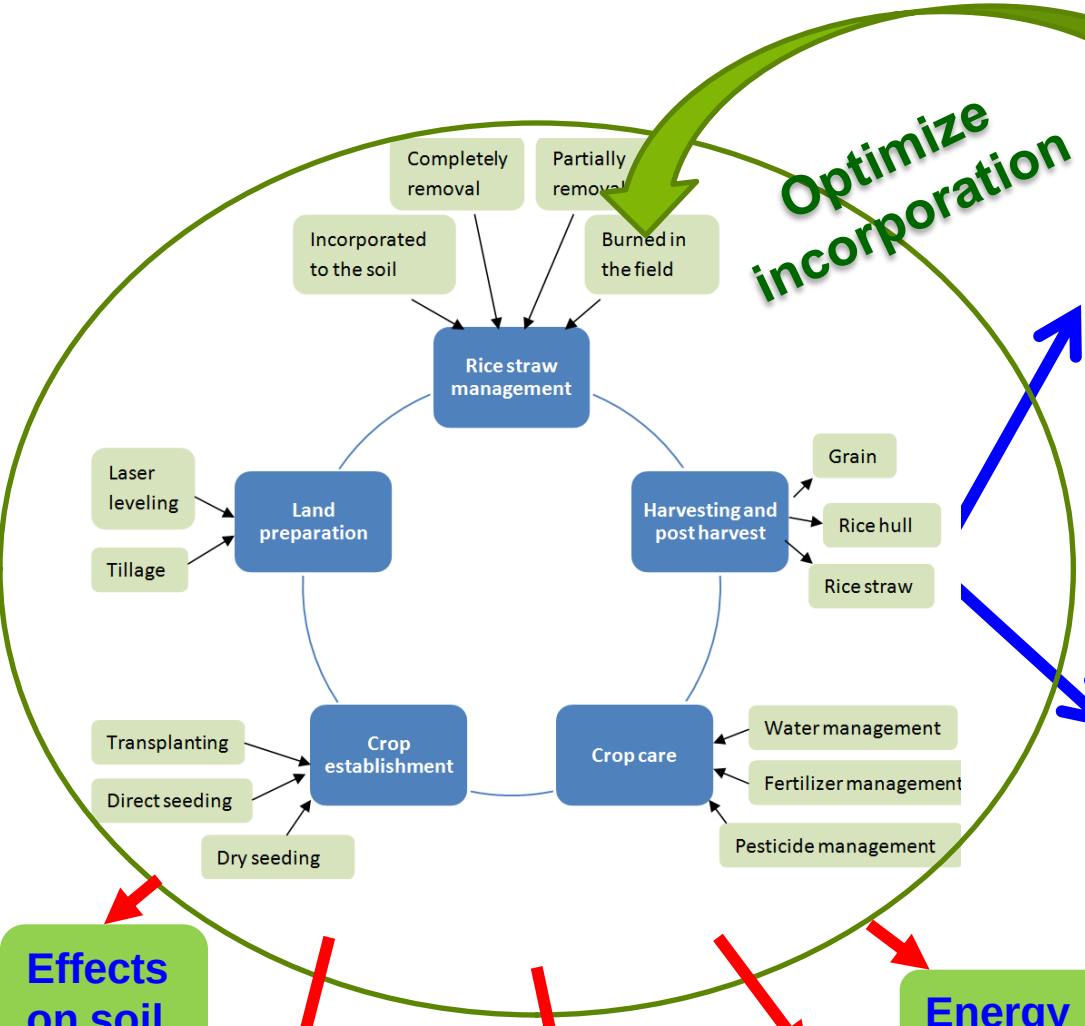
- Resultados después de tres meses de almacenamiento

CIMMYT

Rice Straw Management

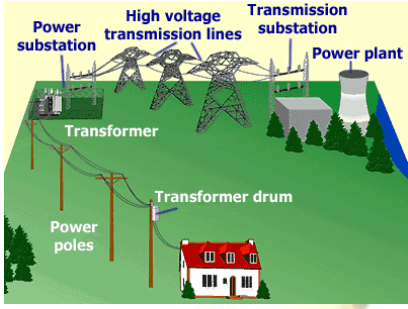
- **Management options** to reduce GHGE emissions; energy balance analysis; life cycle analysis
- Piloting of technologies on alternative uses of rice straw, adding value for farmers
  - *mushroom production*
  - **soil incorporation**
  - animal feedstock
  - anaerobic digestion for energy and fuel
- Technology for rice straw collection with baler machine – **business models** development

Rice Straw Management



Optimize incorporation

Non-energy



Energy

Effects on soil

GHG emission

Nutrient balance

Carbon balance

Energy balance

E.g. Using rice straw for biogas production

GHGE ➔ useful CH_4

Biogas production

Rice straw collection

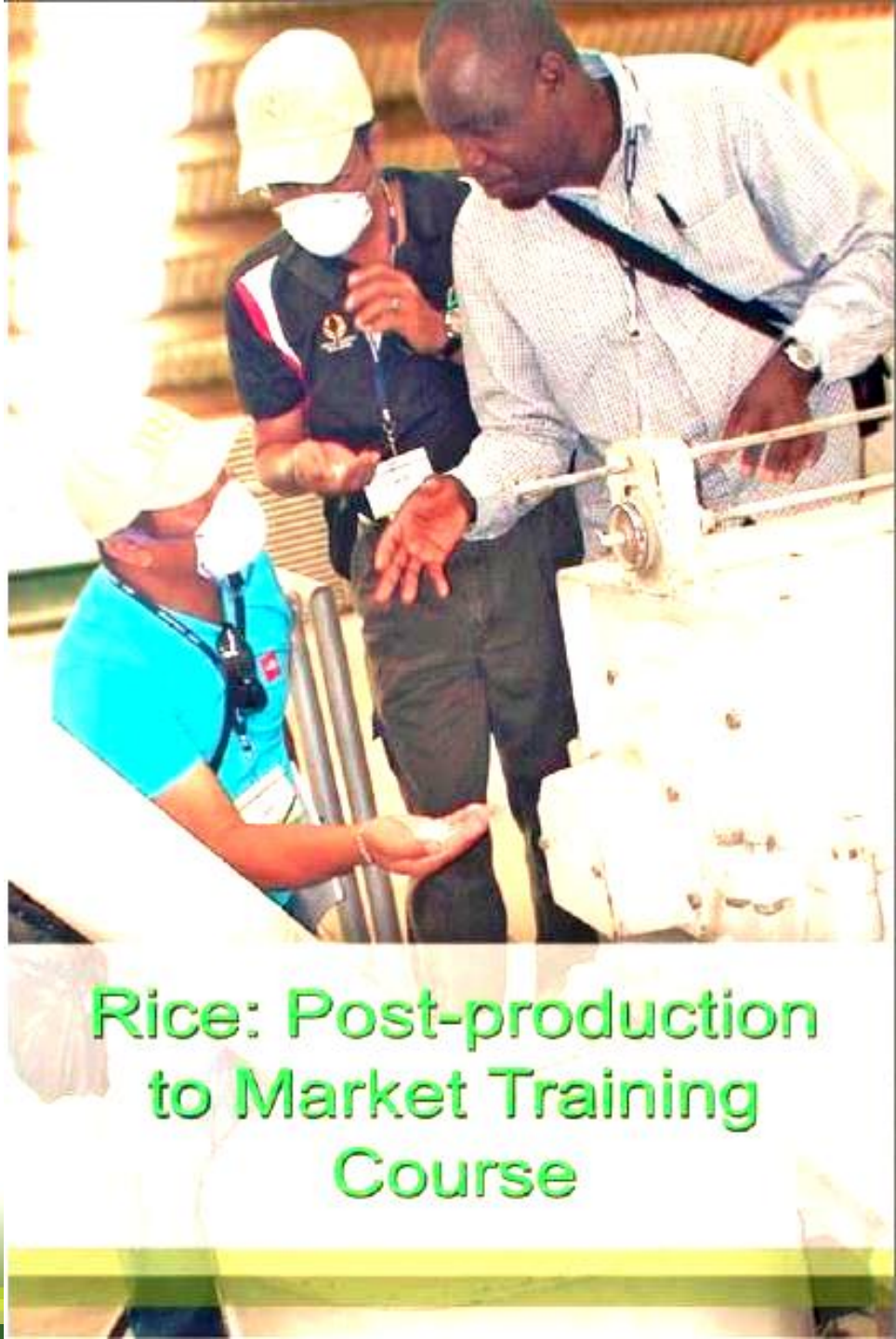
Certification

- Successful candidates are awarded **IRRI Accredited Postharvest Trainer** which qualifies them in:

(1) Practical post-production skills.

(2) Use of the IRRI Quality Kit for assessing the quality of paddy, milled rice & seeds.

(3) Understanding rice markets and rice quality standards.



Certification

- **Rice: Postproduction to Market training course**

(4) Selection of suitable technology and management options for post-production.

(5) Developing a project design framework and a business plan involving multiple ‘actors’ in the post-production landscape.

(6) Familiarity with post-harvest knowledge resources.

▪ Laser leveling training course

This course teach the benefits of **land leveling** and impart skills in using laser technology through field exercises and classroom discussions.

A ***certificate*** to accredit practitioners is being initiated.

Offered at IRRI on a full cost recovery basis.

Certification

- **Tractor safety and operators' training certificate**

A training course aimed to update skills and knowledge of equipment operator at IRRI Experiment Station with focus on safety, maintenance and proper usage.

Present collaboration with **Technical Education Development Skills Authority** (TESDA) targets the delivery of "Agricultural Machinery Safety and Operation Training courses in the Philippines" for TESDA TVET trainers.

Tractor safety and operation training at IRRI

- Focuses on proper maintenance, correct usage, and ***Safety and Health*** for efficient operation of farm equipment

Testing, Support to NARES, some examples

- Development of certified training courses
  (certification of trainers, not training courses on certification)
- Provision of test protocols to partners
  - Postharvest loss assessment protocols to FAO project in Indonesia
  - Many inquiries on a monthly basis
- Working with national partners on national test protocols
- Training on testing
  - Fan testing (Indonesia, Cambodia..)

IRRI's comparative advantage

- Zeigler Experiment Station for ***field testing under controlled conditions***
- Field testing across ***different rice ecosystems***, ***across different countries*** which are on different stages on the mechanization trajectories
- ***Honest broker***, no national mandate,
  - Independent institute, can provide unbiased information
  - While we work with some companies, our LOAs with them include working on technology principles, not products
- Many ***linkages*** to advanced agricultural research centers

Summary

- IRRI's **mechanization** program aimed at increasing field efficiency, reduce losses, increase income for farmers, and **reduce environmental footprint**
- Multi-stakeholder platform (LA) embraces grassroots participation for scaling out and new models of collaboration on **public-private engagement**
- *Adaptive research* for testing technology in farmers' fields
- Training and Certification of trainers to improve capacity of NARES and HQ staff

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