



# Mechanization of Rice Harvesting – Lessons Learned from Southeast Asia



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34 People to harvest 1 ha/day  
Harvesting cost: US\$ 200-250/ha  
Harvesting losses: 4-6%



# Partly mechanized harvesting systems

16 People / ha / day

Losses: 4-6%





# Combine Harvesting

## Why?

- Labor saving  
- 2 instead of 34 persons / day / ha
- Potential to cut harvesting losses to 1-2%
- Cutting harvesting cost up to 50%



## Key challenges in Asia

- Small farm sizes (average 2ha)
- Small field sizes (0.1-0.5ha)
- Wet fields during wet season
- Difficult field access
- Poor road network
- Predominantly bag handling
- Poor support services







Field access and soil conditions





# Technology: Mini Combine



- 1.2m cutting width
- 1ha/day
- 15-40 hp
- Wheels, sometimes rubber tracks

Source: IRRI.

See also: Phan Hieu Hien. 2021. Mechanization of Paddy Harvesting and Rice Straw Baling in the Mekong Delta of Vietnam. In: Scale Appropriate Farm Machinery for Rice and Wheat Harvesting, Updates from South and Southeast Asia. CSISA 2021.





# Technology: Axial Flow



“Small Rice Combine”

- 2-2.5m cutting width
- 4 ha/day
- 40-100 hp
- Rubber tracks



# Technology: Tangential/axial Flow (TAF)



- > 5 ha/day
- 2-3m cutting width
- 40-300 hp
- Rubber - or steel tracks





# Technology: Head-feed Combine



- 2-4 rows
- 0.2-0.4 ha/h
- 60-100 hp
- Rubber tracks
- Leave straw intact



# Technology: Adapted Wheat Combine



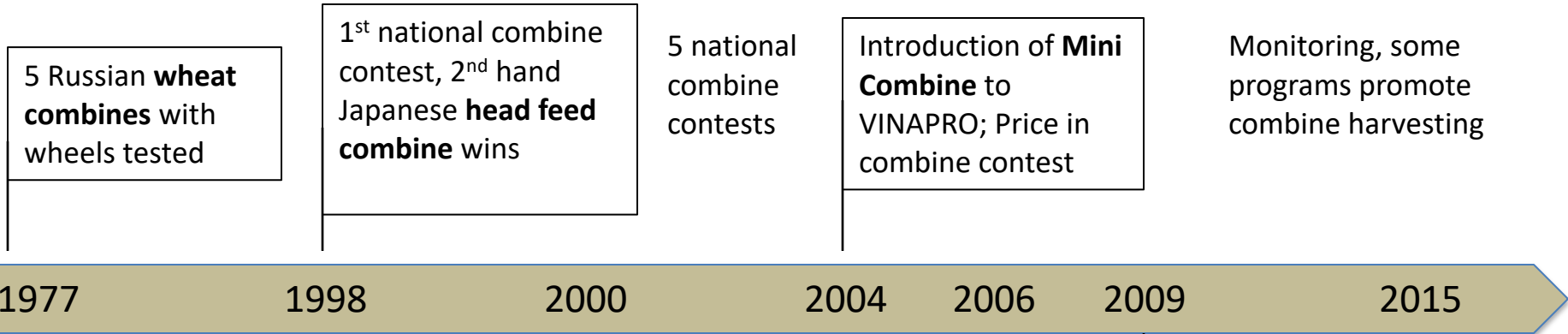
Bago Division, Myanmar, 2014

- 4.3 m
- > 8-10 ha/day
- 140 hp
- Wheels

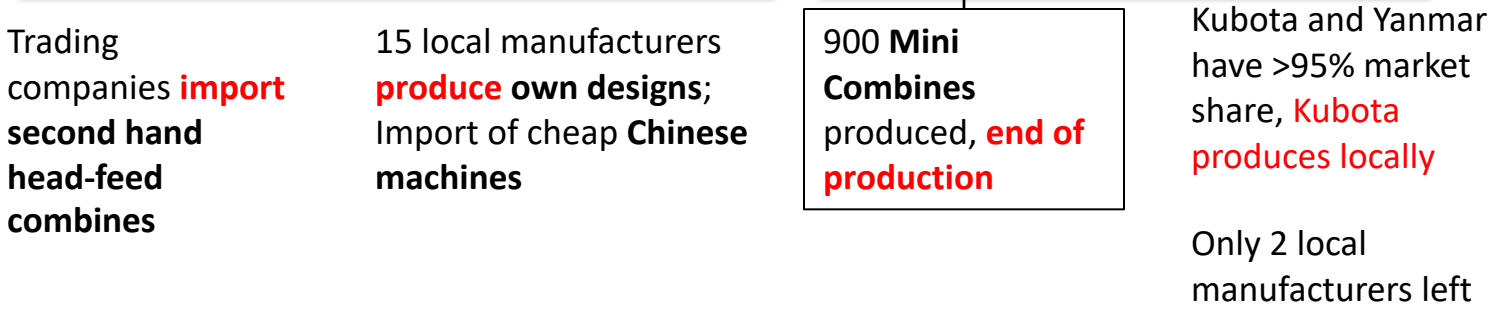


# Introduction of Combine Harvesting, Vietnam

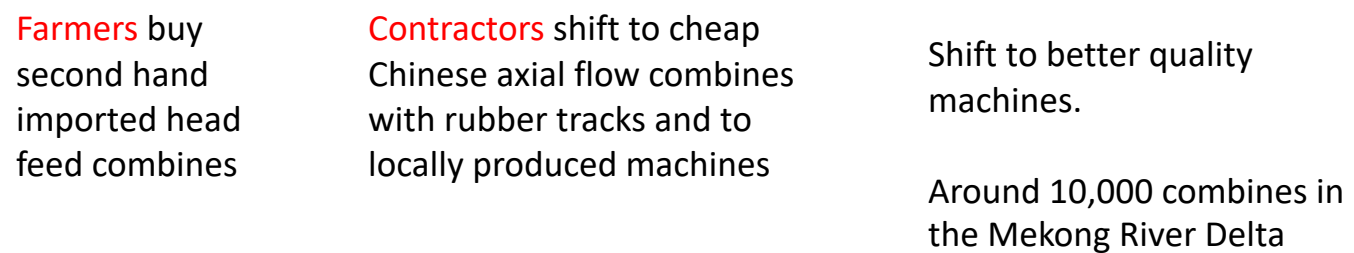
## Public Sector



## Private Sector



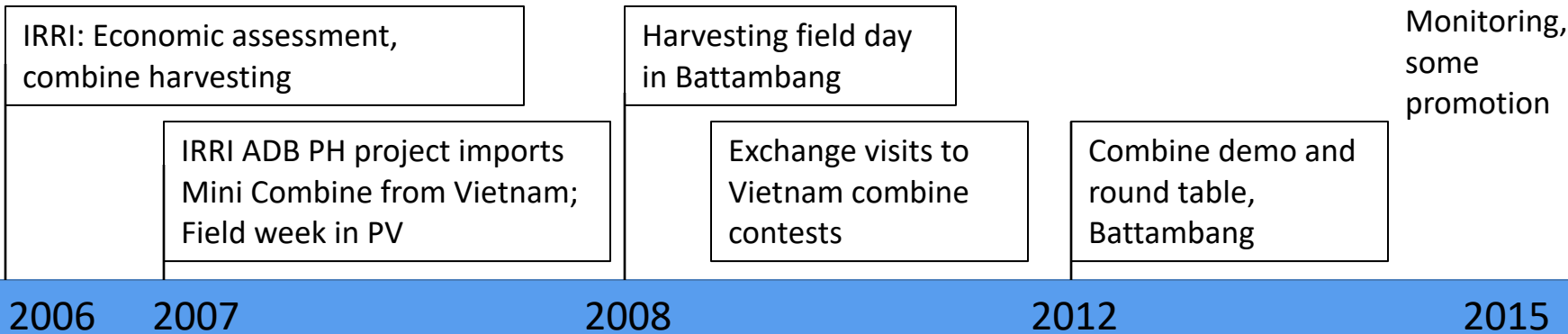
## Users





# Introduction of Combine Harvesting, Cambodia

## Public Sector



## Adaptation

## Adoption

## Private Sector

Participate in events, start **import** combines from Thailand, China

Kubota enters market; Chinese machines increasingly taken out of service

CLAAS multi-crop combine enters market

Kubota >95% market share;  
One local manufacturers makes copies of Thai machines

## Users

Better off **Farmers** buy cheap machines

**Contractors** emerge, shift to better quality machines;  
Farmers start asking for better machines

Contractors prefer Kubota

Around 6,000 combines in around Tonle Sap



# Myanmar: Piloting Phase, Experimenting with Different Combine Types (2015)



Thai TAF



Indian wheat combine



Korean HF



CLAAS TAF, multi-crop



Various Kubota models

## Similar trends

- Users shift to better quality
- Market consolidating started

Source: IIRI IRRC and CORIGAP projects, 2015





# Phases of introduction of combines and support needs

Lesson: We can help countries speed up the introduction of combine harvesting

Phase	Characteristics	Major problems	Public sector support
<b>Piloting</b>	Import of “ <b>cheap</b> ” <b>machines</b> ; local manufacturers copy/develop combines	<b>Identifying machine for cropping system</b> , field size, climatic conditions	<b>Need</b> assessments, baselines, field demonstrations, pilot testing
<b>Adaptation</b>	<b>Modifications</b> addressing problems identified in piloting phase; international players discover market; many local manufacturers	<b>Technical problems</b> ; economic feasibility, lack of financing, lack of after-sales services	Identification of <b>suitable technologies</b> , testing under local conditions; promotion of combines, financing
<b>Adoption</b>	Demand established; market leader evolves; local manufacturers <b>consolidate</b>	High losses (business models), soil compaction, effect of land consolidation	Research on <b>effect of introduction of combines</b> and mitigation options for new problems, sustainability issues

Source: Gummert, VDI-MEG Colloquium Landtechnik, Mähdrescher, Tagung Hohenheim, 12-13 September 2013



# Overview, Combine Populations, Southeast Asia

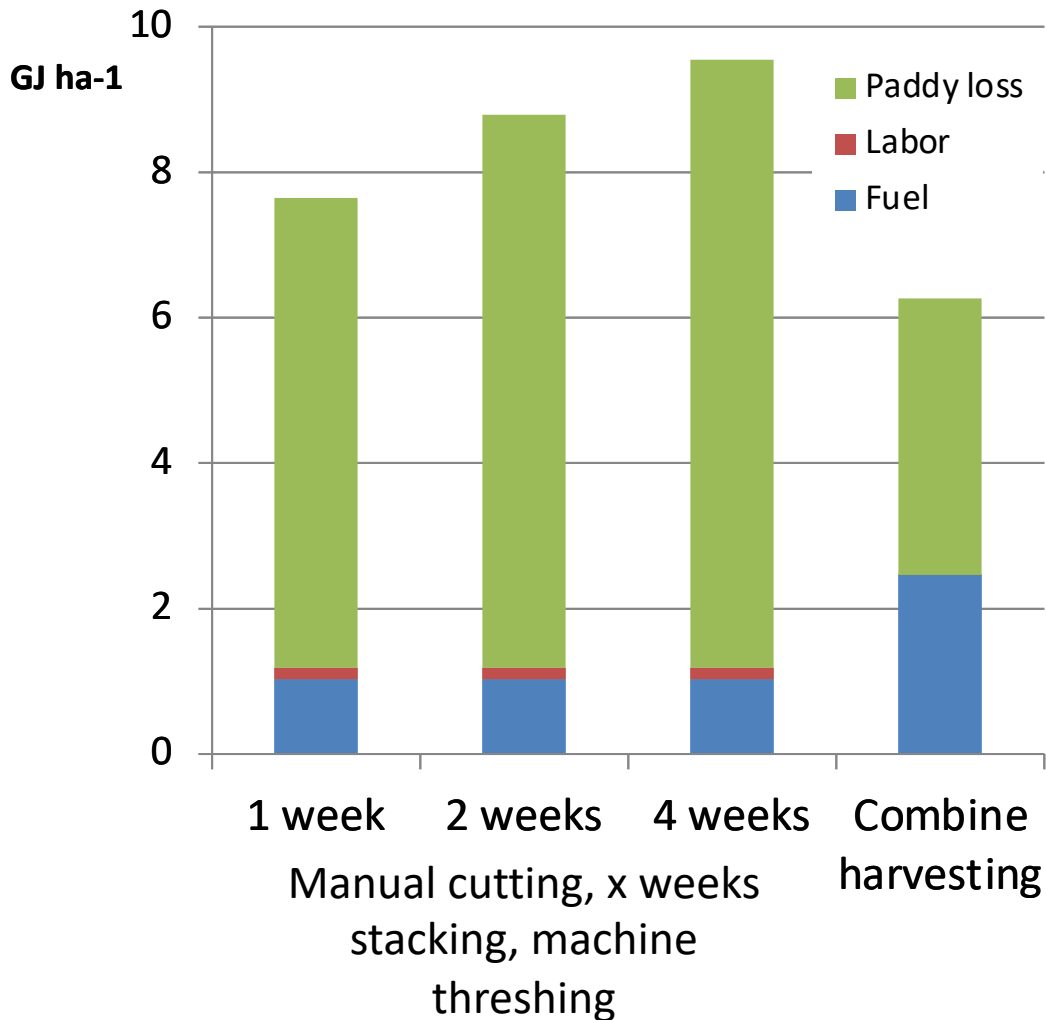
	Machines	Prevailing machines	Major issues
CAM	>5,000, partial saturation	95% <b>Kubota</b> , some <b>Thai</b> combines, <b>CLAAS</b>	Only 20% irrigated rice, low rice price,
VTN	10,000, 9,000 in MRD	<b>Kubota</b> 95% market share, <b>Yanmar</b> , 2 local manufacturers Trend towards more powerful machines	Gov. supports mechanization, move to export quality rice
PHI	1,500-3,000	<b>Kubota</b> , <b>CLAAS</b> , <b>John Deere</b> , some <b>Chinese</b> brands	Government mechanization programs
MMR	Several 100	Chinese mini combines, <b>Kubota</b> , Indian wheat combines, head feed combines from Korea	Increasing labor shortage, government rice sector development strategy, service provision companies
INO	200 South Sulawesi, starting in other provinces	Mostly Chinese machines - branded, <b>Kubota</b> , <b>CLAAS</b> entered market	Labor shortage in outer provinces. Ambitious government program to reach self sufficiency in 5 crops in 5 years

Source: IRRI Trip reports, MyRice, CORIGAP projects





# Energy Consumption of Different Harvesting Methods



## Harvesting system in Myanmar

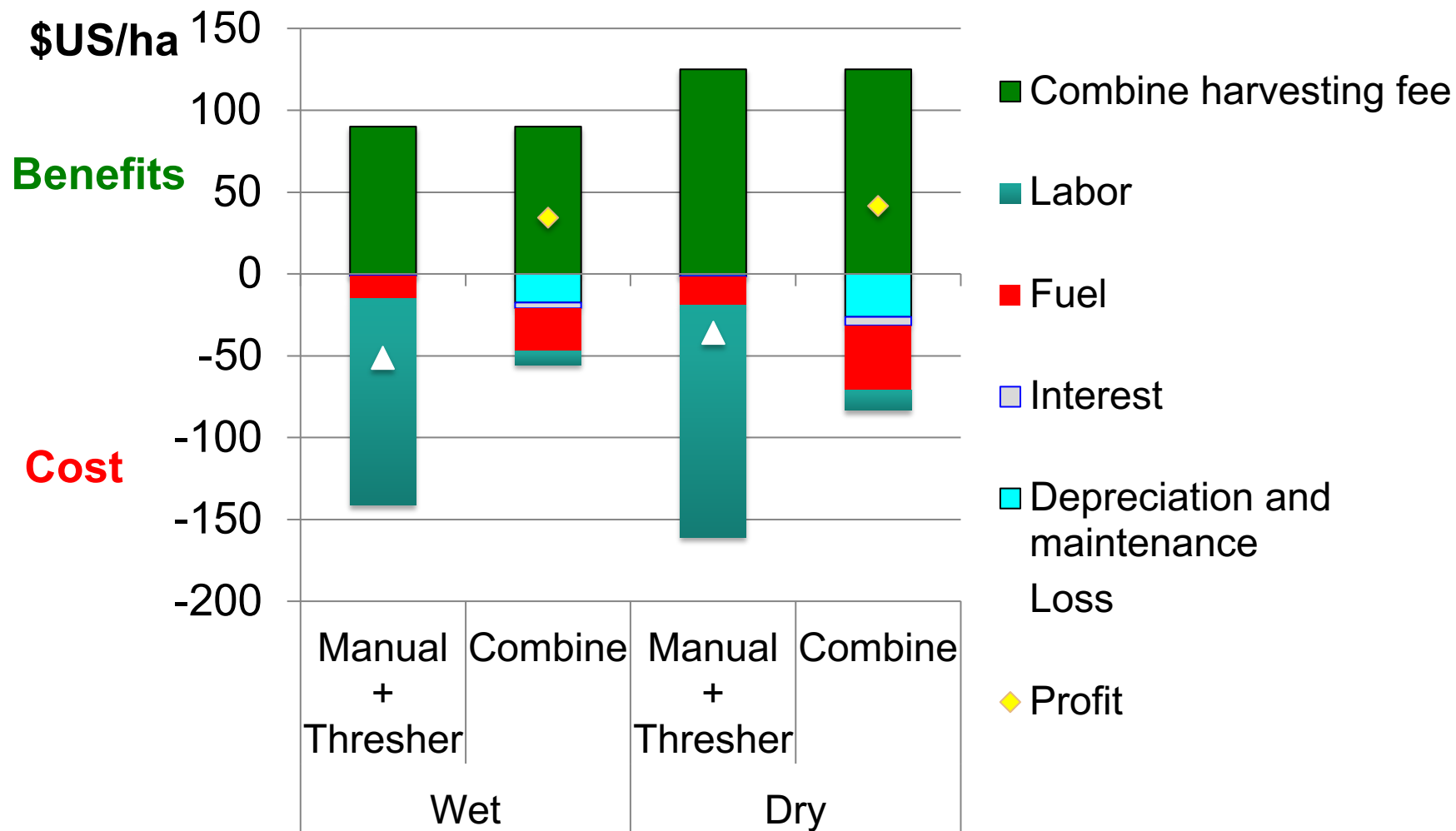


Stacking of unthreshed crop in field	Paddy loss (%)
Manual, 1 week	8.5
Manual, 2 weeks	10
Manual, 3 weeks	11
Combine (assumed)	5

Sources: Nguyen, HV: IRRI MyRice Project, ACIAR, 2016  
IRRI CORIGAP project, SDC, 2016



# Cost and Benefits of Different Harvesting System “Business models”



Source: Book Chapter on Combine Harvesting, for publication, IRRI, 2016





# Typical Combine Harvesting Business Model

- **Ownership:** Mostly individual, 1 or more machines
- **Operation:** Family member or hired operator. Salary: 150-200 US\$/month
- **Harvesting fee:** Cambodia: 70-120 US\$/ha, Vietnam: 90-125US\$/ha  
Manual harvesting and threshing – 200-250 US\$/ha
- **Annual utilization:** Cambodia: 150 days/year, 90 days WS, 60 days DS; Vietnam: 100 days/year, 8 hours / day (640 h/year); some contractors “follow the harvest”
- **Durability / Lifetime of machine:**
  - “Cheap” combines start breaking during the first season
  - Better quality machine “runs for three years without much problems”
  - After 3,000 hours, major re-built
- **Repairs:** During off season, often by owners and local workshops – modifications

Source: IRRI combine market study, 2015



# Special business models in Cambodia / Vietnam in 2014 (still happening in 2022)

- Cambodian contractor **buys a new Kubota** for US\$26,000, **sells it after one year** before major repairs start for \$10,000 to Vietnam.
- Vietnamese workshop **invests \$5,000 to re-build it** and then sell it with a reasonable margin to Vietnamese combine owners
- Vietnamese operator might put another 3,000 hours on the clock.
- Nobody seems to earn much money



One of two Vietnamese manufacturers still making own combines, but also re-building broken machines, mostly Kubota.

Source: IRRI combine market study, 2015  
Personal communication with Dr. Nguyen Van Hung, 2022





# Some Combine Harvesting Problems

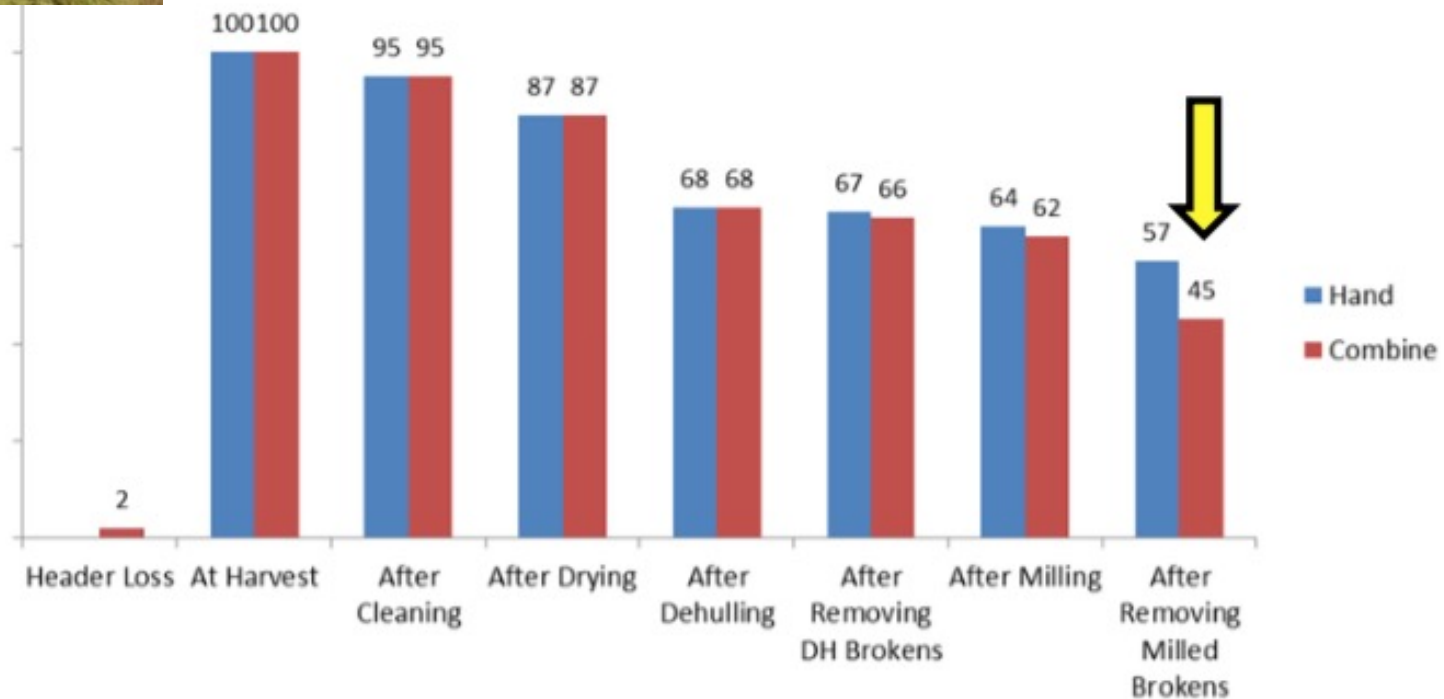
- Harvest losses increased, up to 10%
  - Business model favors operators to drive fast
  - Operators don't know how machine settings affect performance
  - Farmers in a poor negotiating position
- Poor support services
  - Operators get 1 hour of training
  - Spare parts expensive or not available
  - Repair services through local manufacturers
- Logistics
  - Scheduling
  - Right machine for field condition

# Other Effects of Combine Harvesting



## Postharvest Loss Assessment, Chainat, Thailand

Harvesting practice has effects on milling outputs.



Source: IRRI Kellogg's Project, 2016



# Collecting the Grains



Unloading of combines with grain in bags into bags in a tank in Cambodia, Prey Veng Province (left), and onto a transportation vehicle in Pursat Province (right).



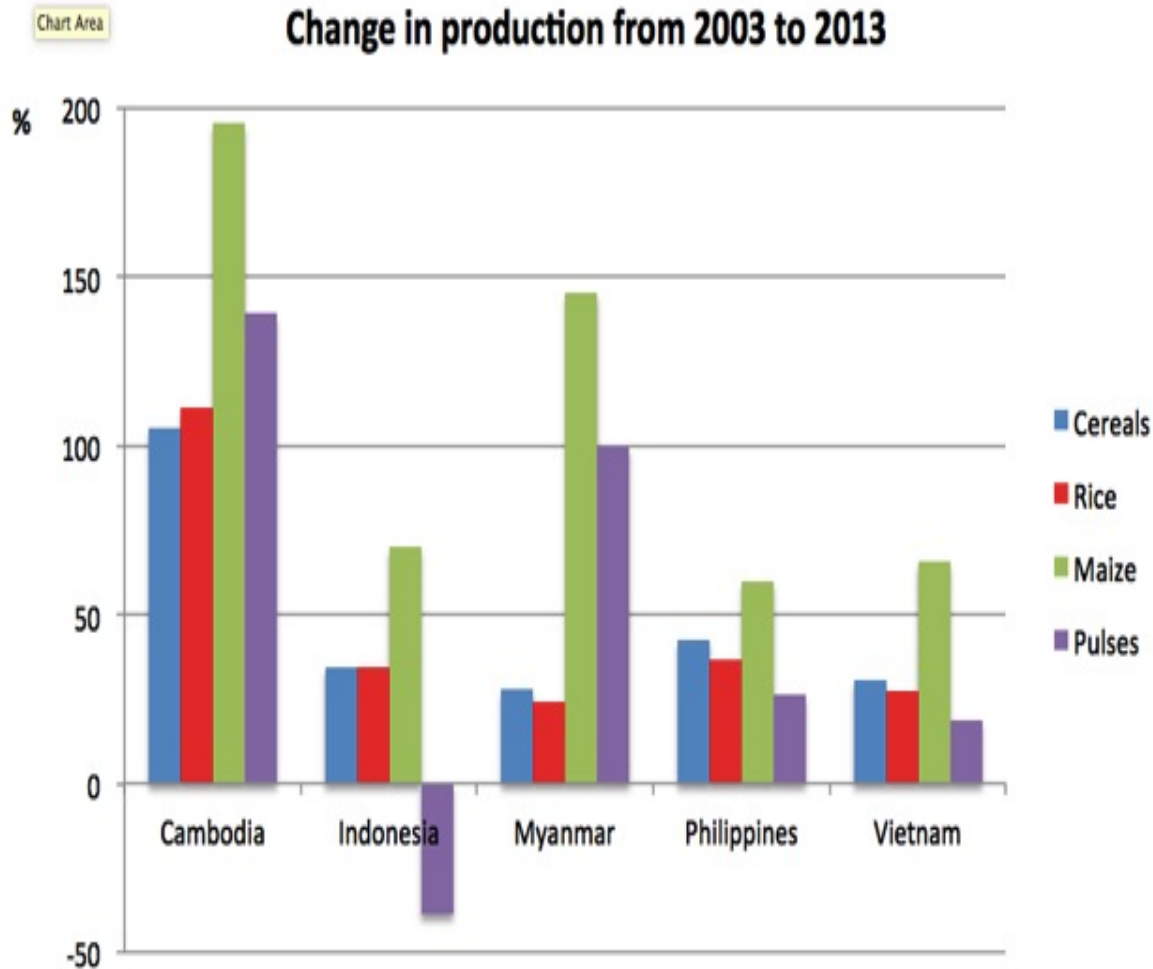
Bag collector picking up bags in the field (left); unloading at the national highway (right). Vietnam

- Bag handling prevailing in S- and SE-Asia ( $\approx 95\%$ )
- Deltas: no field roads, transport on canals
- Slow increase in bulk handling in the intensive systems with farm roads

Source: IRRI CORIGAP project, 2015



# Crop Rotation



## Trends

- Increase of rice production in all countries
- Over proportional increase in maize production
- Increase in pulses, except Indonesia

Multi crop capability will be more important

Source: IRRI, FAO data





# Combine harvesting leads to higher MC and more grain coming to the drying systems in shorter time - need for dryers



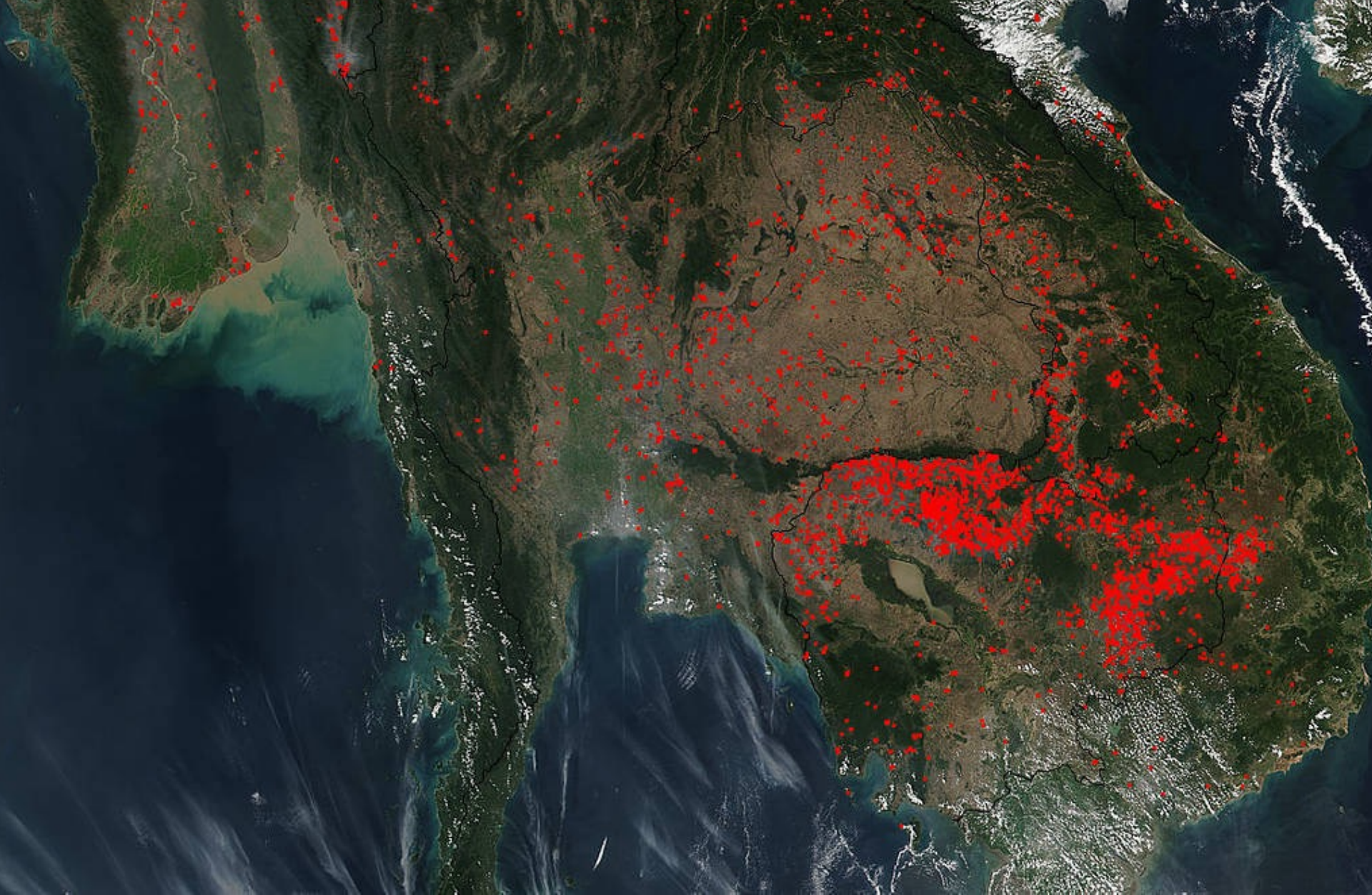
Traditional sun drying in Indonesia (top left); flat-bed dryer at rice mill in Myanmar (top right); re-circulating batch dryer in Vietnam (bottom left); Solar Bubble Dyer in Indonesia (bottom right).



Source: IRRC, CORGAP







Hot spots from burning of agricultural by products, Source: NASA





# Effect of Combines on Rice Straw Management



Traditional harvesting, straw collected



Field burning of straw after combine harvesting

Need to introduce sustainable rice straw management

Source: IRRI BMZ project, 2015;  
Supergen project 2014



# Conclusions, SE Asia

- Viable combine harvesting service business model with clear benefits for operators and farmers
- Combine introduction happening fast - similar trajectories across countries
  - Initially cheap machines -> Better quality
- Potential for learning from each other
- All moved towards the “small rice combine”
  - AF or TAF, tracks, 2-2.5m width, bagging station or grain tank
  - Increases in Capacity in Vietnam in last years
- New problems: drying, rice straw management soil compaction, etc. need adaptive research in those areas
- Attention needed to optimizing logistics, scheduling, field efficiency, after sales services





The IRRI logo consists of the letters "IRRI" in a white, serif font, centered within a solid green square.

IRRI

A young boy is the central figure, carrying a large bundle of harvested rice stalks on a wooden pole across his shoulders. He is wearing a plaid cap, a blue and white striped shirt, and a brown and white checkered scarf. The background shows a clear blue sky and more rice stalks.

**Thank You**

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