# Sustainable mechanization in rice research and rice agri-food systems

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# Sustainable mechanization in rice research and rice agri-food systems

1. Drivers of change in rice agri-food systems

2. Research
    a. Research on mechanization
    b. Mechanization in research

3. Successful mechanization

# Acknowledgements

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# Definition of Mechanization

**"Mechanization is the process or system of introducing equipment and/or machines to do work"**

- **Technology**
  - Hand tools, animal power, engine driven
  - Different level of complexity and control
  - Common patterns of adoption
- **Delivery**
  - Central or local fabrication; Distribution networks
- **Seed to markets**
  - Includes whole value chain
- **Support services**
  - After sales services, repair, financing, training
- **Supportive policy**

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# Constraints in agri-food systems

- Availability of labour
- Cost of energy
- Water availability
- Climate change
- Aging agricultural population

*Constraints in research*

- Seed processing
- Sample collection and preparation
- Phenotyping


2002 2014 Metro Manila

# Mechanization - Major Benefits and Constraints

- **Benefits**
  - **Increased efficiency** in farming, resource efficiency, intensification
  - **Minimizing cost**
  - Optimization of product quality
  - Reduction of drudgery
  - Creation of jobs in the supporting industry
  - **Keeps farming interesting for young people**
- **Constraints**
  - Small farm sizes
  - Weak private sector, in particular in R&D
  - Lack of institutional capacity in R&D, testing, training
  - Lack of suitable machinery options
  - Lack of unbiased information
  - Lack of support services (financing, training, business development)
- **Threats**
  - Displacement of labor
  - Potential inequities (women, landless farmers)
  - Effects on soil, cropping systems and GHG emissions

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# Diversity of research at IRRI






# Research on mechanization

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

## Straw incorporated after mechanized harvesting of irrigated rice affects net emissions of $CH_4$ and $CO_2$ based on eddy covariance measurements

Ma. Carmelita R. Alberto[a,*], Reiner Wassmann[a,b], Martin Gummert[a], Roland J. Buresh[a], James R. Quilty[a], Teodoro Q. Correa Jr.[a], Caesar Arloo R. Centeno[a], Gilbert M. Oca[a]

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[b] Karlsruhe Institute of Technology, Karlsruhe, Germany

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

## Energy efficiency of rice production in farmers' fields and intensively cropped research fields in the Philippines

James R. Quilty[a,*], Justin McKinley[b], Valerien O. Pede[a], Roland J. Buresh[a], Teodoro Q. Correa Jr.[a], Joseph M. Sandro[a]

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# Research on mechanization

- Two wheel multi-crop seed drill development
- Mechanized agronomy
- Drying technologies
- Energy efficiency of mechanization
- Straw management
- Reduced tillage mechanical transplanting
- Bioenergy production
- Gender and equity studies

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# Mechanization of research

Crop establishment – precision agriculture

Harvest & postharvest

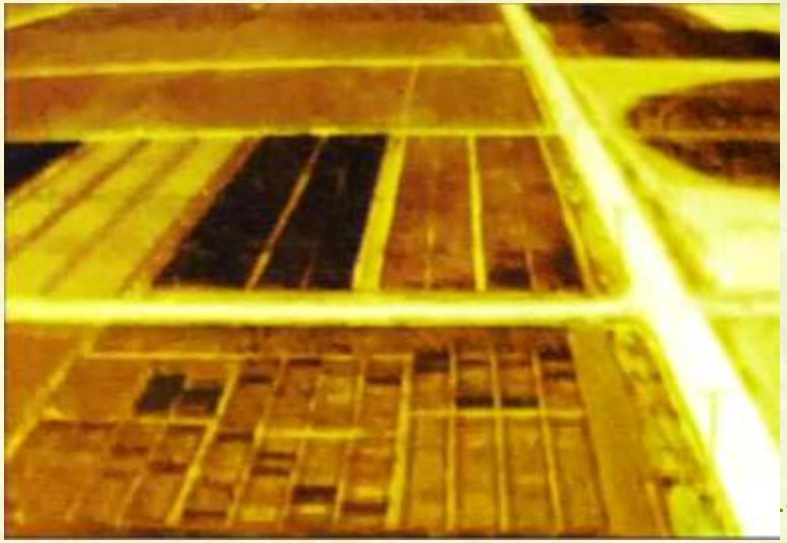
# Phenotyping

## Tractor mounted system

**Multispectral Reflectance**
**Canopy Temperature**
**Canopy Height**
**HD Video/ 8 MP RGB**
**Georeferenced @ 2 cm**
**GPS Auto-steer tractor**

## Drone platform

**Multispectral cameras**
**Thermal imagery**
**High resolution**



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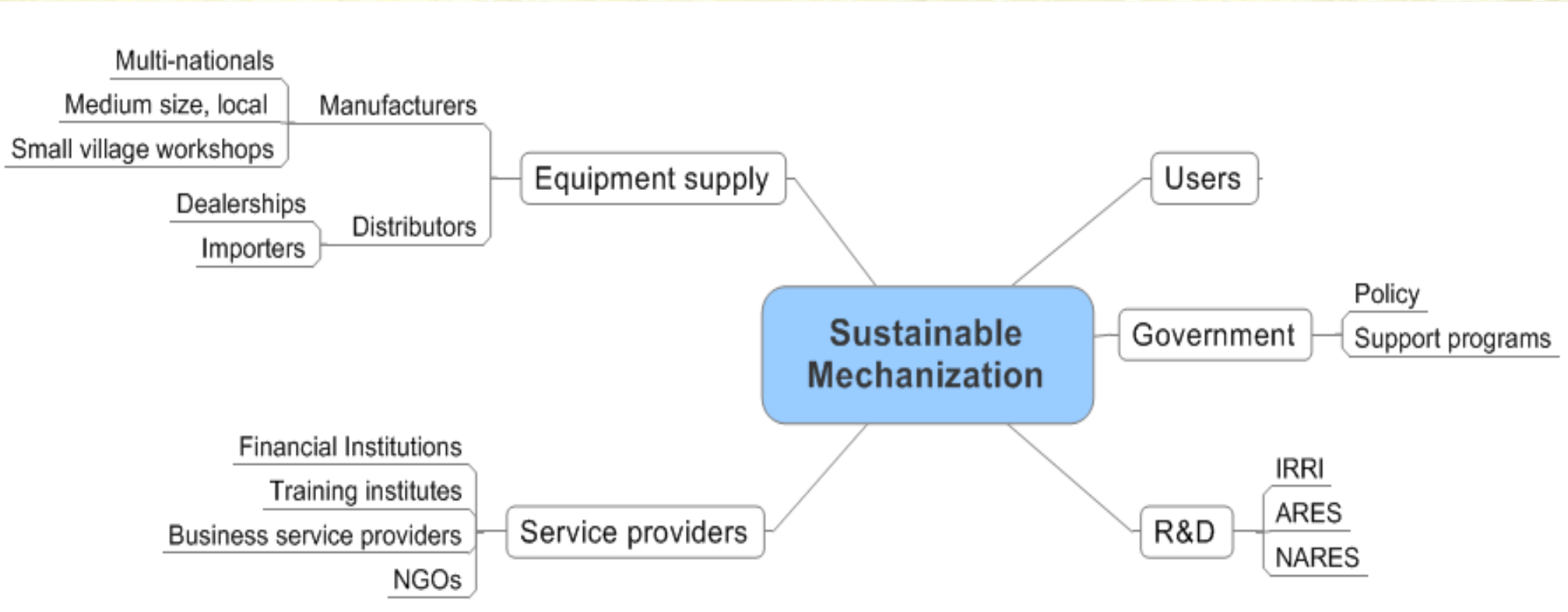
# Stakeholders




Promoting mechanization is more difficult than disseminating seeds

# Successful mechanization

Some examples

- Axial flow threshers
- Hydrotillers
- Combine harvesters
- Drying systems
- Laser leveling
- Mechanical transplanting

# Successful mechanization projects ....

1. Addressed a real need
2. Facilitated a multi stakeholder platform
3. Used appropriate technologies
4. Conducted participatory piloting
5. Used good practice approaches
6. Did support and advocacy
7. Did capacity building at all levels
8. Included industrial extension
9. Helped establish equipment supply chains
10. Had sufficient resources and time

# Training is essential

- Operator training
- Health and safety
- Service and maintenance

# Key lessons learnt

- **Private sector** is the key for manufacturing, distribution, adaptive development
- **Researchers stayed involved** to take the technology to the next step
- Technology **champions** and **multi stakeholder platforms** were important
- Standardization / certification was often misused = counterproductive
- Where ever governments distributed equipment it lead to failure

# Summary

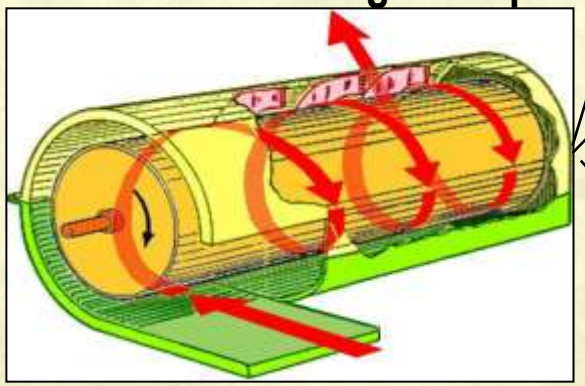
- Inclusive approach involving all stakeholders along the rice value chain is needed
- Private sector is essential and should be driving mechanization, the government should facilitate an enabling environment
- Interventions need to be tailored to phase of introduction of a technology
- Many experiences with sustainable mechanization exist
- IRRI is ready to work with national partners

# Some examples of IRRI's experience

# The Benchmark: Axial Flow Thresher

**Green revolution**
Yield increases
Double cropping systems

**Axial Flow Threshing Principle**



IRRI, 1972


**Introduction in Countries**
Philippines, 1969-1972
Pakistan, 1976-1978
Thailand, 1977-1980
Indonesia, 1980-1982
Lao, 1997-1998
Vietnam, 1980s?

**Combine Harvester**
Thailand: mid 1990s
Vietnam: since ~ 2000

# Axial flow thresher

- **Simple technology**, no change in cropping system needed
- Drivers: Green revolution, increased yields, very wet crop -> **need for mechanized threshing**
- Impact: Transferred to most Asian countries, hundreds of manufacturers
- Support services included in program
  - Industrial extension program (Small Farm Machinery Development Program)
  - Sustained funding for 10 years, large, interdisciplinary RD team
- Policy: Supportive in context of green revolution
- Roles of stakeholders
  - IRRI: R&D, industrial extension
  - NARS: Piloting, agricultural extension
  - Industry: Manufacturing and marketing

# Hydrotiller: Factors contributing to successful uptake

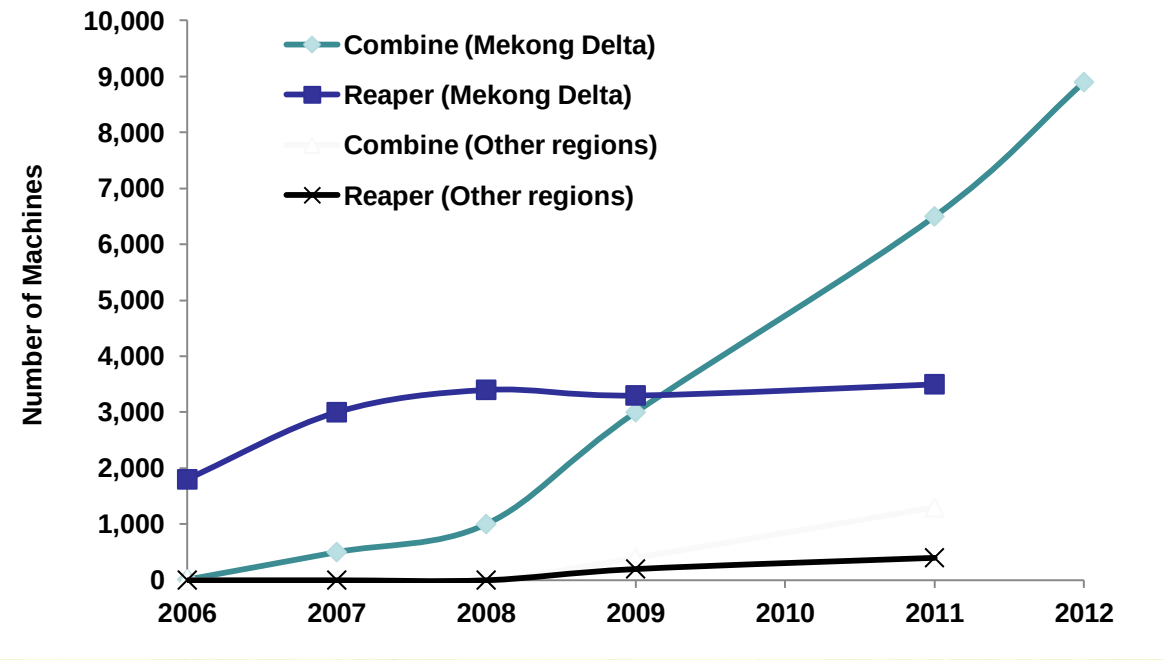
- Sound and affordable technology adapted to local conditions
- “Pull” and “push”
- Technology champion
- Critical mass (personnel, funding)
- Time frame (6-10 years)
- Business case
- Partnerships
  - Early inclusion of the private sector
  - Research did not disconnect
  - Some sort of multiple stakeholder platform

# Combine harvesting

# Combine harvesters in Vietnam: Status, Trends, Needs

## Status and Trends

- Losses reduced from 5-6% to 2%
- By 2020, 80% of rice harvested by 18,000 combines
- No. of combines anticipated to double in next 7 years
- Afterwards replacement: 3,000-4,000 per year




## Needs

- Support services (joint ventures)
- More competition
- Mini combine for unfavorable systems?

# Remaining Challenges: Combines in Cambodia and Vietnam, Nov. 2014

- **High losses**: Untrained operators, business model
- **Market saturation** in some areas: Harvesting fees drop from US$120/ha to US$70/ha
- **No after sales services**:
  - Contractors in Cambodia buy a new machine for US$ 26,000, use for one year and sell it second hand to Vietnam for US$ 10,000. Needs to do 300 ha to recover investment, or 100 days
  - Vietnamese workshops re-condition and sell for US$ 15,000, cheaper than import of new machines (taxes)
  - Second life in Vietnam, up to 3 years before another re-build
- Nobody makes much money, farmers benefit, but is it sustainable?

# Laser leveling

- Complex technology, requires advanced manufacturer
- Drivers: Water management, lodged crop, grain quality, nutrient use efficiency
- Impact: Contract service providers in India (10,000), China, Pakistan, initial adoption in Cambodia (8) and Vietnam (60)
- Support services
  - Subsidies in India
  - Sustained promotion for >6 years
- Policy: Supportive
- Roles of stakeholders
  - IRRI: R&D, industrial extension, piloting, capacity building
  - NARES: Piloting, agricultural extension, training
  - International Industry: Manufacturing and marketing
  - Local industry: Manufacturing bucket, contract service provision
  - (no government distribution, except in Vietnam)