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TRAINING MANUAL

Creating an Enabling Environment for Custom Hiring of Agricultural Machinery in Myanmar's Dry Zone

Funded by

LIFT Livelihoods and Food Security Trust Fund

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Creating an Enabling Environment for Custom Hiring of Agricultural Machinery in Myanmar's Dry Zone

Developed as part of the project

An Integrated Rural Economic and Social Development Programme for Livelihoods Improvement in the Dry Zone of Myanmar

Funded by

Livelihoods and Food Security Trust Fund

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Abbreviations

AFC	Annual fixed cost
AIC	Agro-industries corporation
AICRP	All India Coordinated Research Projects
AMTs	Agricultural mechanization technologies
Ave. annual	Average annual
BBS	Bangladesh Bureau of Statistics
BCR	Benefit-cost ratio
BDT	Bangladesh taka
BEP	Break-even point
BSAM	Beneficiary systems of agricultural machinery
CAM. SUR	Camarines sur
CDT	Closed drum thresher
Chem. App.	Chemical application
CH	Custom hiring
CHS	Custom hiring services
CHRSAM	Custom hiring for rental services of agricultural machineries
CSAM	Centre for Sustainable Agricultural Mechanization
CSF	Crop supporting fund
D	Depreciation
Dev't	Development
DF	Discount factor
DTW	Deep tube well
eqn	Equation
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organization
FIM	Farm implements and machinery
GDP	Gross domestic product
GOI	Government of India
Govt.	Government
HH	Household
H/ha	Hill per hectare
HIR	Higher interest rate
Hp/ha	Horsepower per hectare
Hp	Horsepower
hr	Hour
HSRT	High speed rotary tillers
I	Initial investment

IC	Initial cost
Inc	Incorporated
IOI	Interest on investment
IRSAM	Institution for Rental Services of Agricultural Machineries
IRR	Internal rate of return
JICA-TBIC	Japan International Cooperation Agency - Tsukuba International Center
Kg	Kilogram
Km/h	Kilometre per hour
KVKs	100 agriculture science centres
LIFT	Livelihoods and Food Security Trust Fund
LIR	Lower interest rate
Lit	Litre
LLP	Low lift pump
M	Metre
Mech.	Mechanization
Mid-	Middle
Mil.	Million
MRD	Mekong river delta
MT	Metric ton
NAFMP	National Agricultural and Fishery Mechanization Programme
NAIP	National Agricultural Innovation Project
NATP	National Association of Tax Professionals
NGOs	Non-governmental organizations
NICRA	National Initiative on Climate Resilient Agriculture
No.	Number
NPW	Net present worth
NVP	Net present value
ODT	Population of open drum thresher
O&M	Operations and maintenance
PAES	Philippine agricultural engineering standards
PRA	Participatory rapid appraisal
PARCA	Participatory rapid community appraisal
PBP	Payback period
P&D	Pest and dry rot
PDR	People’s Democratic Republic
PhP	Philippines peso
POs	Private organizations
PPP	Public private partnership
Prep	Preparation
PRSA	Participatory rapid and systematic appraisal
PRRA	Participatory rapid rural appraisal
PSB	Philippine seed board
PT	Power tiller
PTOS	Pt operated seeders

PW	Present worth
PWB	Present worth benefits
PWC	Present worth costs
Rc	Rice
RCA	Rapid community appraisal
RDE	Research and development extensions
R&M	Repair and maintenance
Rp	Rupiah
RPP	Required pay back period
RRA	Rapid rural appraisal
RRD	Red river delta
RRR	Required rate of return
Rs	Rupees
Sq	Square
SRR	Simple rate of return
SSI	Semi-structured interview
Stat	Statistics
STW	Shallow tube well
SV	Salvage value
tons/ha	Tons per hectare
UPLB-BAR	University of the Philippines Los Baños and Bureau of Agricultural Research
USA	United States of America
USD	United States dollar
USG	Urea super granule
VC	Unit variable cost
VLMPC	Villa Luna Multipurpose Cooperative, Isabela Philippines
WT	Wheel tractor

Foreword

The agriculture sector has traditionally been the dominant economic sector in the Union of Myanmar and it remains an important contributor to the country's GDP. The agricultural land is mostly cultivated by small-scale farmers. In the Dry Zone, farm holdings generally range from small to medium size (1.4-2.6 ha for rice; 3.6-5 ha for other crops). Climate change, environmental stress, farmers' migration, and lack of financial resources and technical skills serve as drivers for the local farming population to turn to custom hiring of agricultural machinery.

Regional experiences show that custom hiring of agricultural machinery is an effective way to enable farmers to utilize the appropriate equipment and to benefit from technological advancement, without shouldering the high purchase cost of agricultural machines. It is also an efficient tool to catch the shortened window period for conducting critical agricultural operations due to climate change. Custom hiring is a relatively common phenomenon in the Dry Zone. Irrespective of the farm size (small or medium) or the farming system (rice based or upland field-crop based), farmers generally utilize custom hiring services. Nevertheless, the existing custom hiring practices and models in the Dry Zone seem to be quite rudimentary and not well aligned to meet its growing needs.

A number of weaknesses, constraints and threats exist in the enabling environment for custom hiring services in the Dry Zone, including areas such as the platform and network for custom hiring services, extension support, local manufacturing capacity, dealership network, information and knowledge-sharing channels, operational costs of the service providers, infrastructure, agricultural engineering education and training, the network of academic research and development institutions, human resources development, links between research and development and commercialization, testing, standardization and quality control of the agricultural machines, market competition and machinery-related service and maintenance, and so on.

This training manual aims to strengthen capacities of key stakeholders to address some of these constraints and has been produced by the Centre for Sustainable Agricultural Mechanization under a project supported by the Livelihoods and Food Security Trust Fund (LIFT). We sincerely hope that it will serve as a valuable knowledge resource for relevant stakeholders to jointly create and improve the enabling environment for custom hiring of agricultural machinery and to support climate-resilient agriculture in Myanmar’s Dry Zone.

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The lecture document on *Conceptual Framework for Custom Hiring of Agricultural Machinery*, developed by Dr Rossana Marie C. Amongo, Director of Institute of Agricultural Engineering & College of Engineering & Agro-industrial Technology of University of the Philippines Los Baños, and the presentation on *Prevailing Practices in the Region,* developed by Dr Peeyush Soni, Associate Professor & Coordinator of Agricultural Systems & Engineering of Asian Institute of Technology under their consultancy assignment with CSAM have provided main reference for compiling and developing this training manual. Ms Lian Zhang, Operation Facilitator of CSAM compiled and edited the workshop materials and developed this training manual.

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Executive Summary

This training manual outlines a conceptual framework for the enabling environment for custom hiring of agricultural machines in the Dry Zone of Myanmar and shares experience of neighbouring countries by providing custom hiring service status from 15 countries in the Asia-Pacific region.

Custom hiring services for agricultural machinery enable farmers to utilize the appropriate equipment for a defined period of time, only paying for the services. There are several factors that motivate the establishment of the service as well as some challenges associated with the service. Enabling environment is critical for the service providers to establish and sustain the custom hiring business.

The social-political environment together with the availability of support services (such as credit facilities, infrastructure and supporting policies) serve as the foundation for the custom hiring services. Some of the key stakeholders in the enabling environment for custom hiring services include government, research and development extensions, financial institutions, machinery manufacturers, non-governmental organizations, private organizations and the private sector, farmer beneficiaries and custom hiring service providers.

The establishment of custom hiring services should consider technical, sociocultural and economic aspects of the targeted environment for both the users and the service providers. Area assessment should be conducted for this purpose with proper techniques.

Custom hiring status and experience from 15 countries in the Asia-Pacific region, namely Bangladesh, Cambodia, China, India, Indonesia, Lao People's Democratic Republic (PDR), Malaysia, Mongolia, Nepal, Pakistan, Sri Lanka, Thailand, the Philippines and Viet Nam provides a reference on how custom hiring services are conducted in the region.

1 Introduction

1.1 Objectives

This training manual aims to provide a conceptual framework for establishing an enabling environment for custom hiring of agricultural machinery in the Dry Zone. Prevailing practices on custom hiring services from 15 countries in the region, namely Bangladesh, Cambodia, China, India, Indonesia, Iran, Lao People's Democratic Republic (PDR) , Malaysia, Mongolia, Nepal, Pakistan, Sri Lanka, Thailand, the Philippines and Viet Nam are shared to provide reference and considerations.

By studying the training material, the trainee is expected to be able to:

- Understand the benefits and challenges associated with custom hiring services and key stakeholders that are necessary for the establishment of the service
- Develop one framework to facilitate custom hiring of agricultural machinery in the selected region
- Discuss the key aspects that affect the establishment of custom hiring services
- Develop procedures to conduct area assessment for custom hiring services
- Discuss the characteristics and uniqueness of custom hiring services in the 15 neighbouring countries.

1.2 Definition of agricultural mechanization

a) Popular definitions of agricultural mechanization

- Agricultural mechanization is the application of animal and machine power to multiply human ability to perform production operations. Mechanization permits a farmer to multiply production by the use of animal or fuel power. Mechanization allows the performance of tasks efficiently (Loyd Johnson, 1964).
- The use of hand- and animal-operated tools and implements as well as motorized equipment to reduce human efforts, improve quality, perform operations that cannot be done by other means, and improve the timeliness of various operations, thereby increasing yield, quality of product and overall efficiency (Stout and Downing, 1974).
- Agricultural mechanization embraces the manufacture, distribution, utilization and provision of after-sales service of tools, implements and machines for land development, agricultural production and primary post-production processes. It includes the use of three main sources of power: human, animal and mechanical (FAO, 1979).

- Agricultural and fisheries mechanization refers to the development, adoption, assembly, manufacture and application of appropriate, location specific and cost-effective agricultural and fisheries machinery using human, animal, mechanical, electrical, renewable and other non-conventional sources of energy for agricultural production and post-harvest/ post-production operations consistent with agronomic conditions and for efficient and economic farm and fishery management towards modernization of agriculture and fisheries (RA 10601, 2013).

b) Models of mechanization
   - High land area to farmer ratio (e.g. USA): Motivated into increasing the level of mechanization in order to cultivate large agricultural lands with limited available manpower and take advantage of favourable agricultural commodity prices.
     Thailand, Malaysia and Indonesia follow the USA model.
   - Low land area to farmer ratio (e.g. Japan): Motivated into increasing the level of mechanization in order to increase yields and cropping intensities to meet the growing demands for food and agricultural raw materials.
     South Korea, China, Taiwan, Sri Lanka and the Philippines follow the Japanese model.

1.3 Potential of agricultural mechanization

a) Increased cropping intensity and production
   - Tractors, power tillers, irrigation pumps, harvesters and threshers increase cropping intensities
   - Irrigation pumps increased yields
   - Harvester and threshers/shellers reduce losses, which effectively increases yields

b) Increased productivity of labour
   - Tractors in land preparation reduced labour inputs by 50 per cent
   - Freed family labour can look for alternative work opportunities; children can go to school

c) Full utilization of farm products and by-products
   - Availability of machines allow the processing of farm products and by-products

d) Reduction of losses
   - Development of harvesting, threshing and processing machines reduce harvest and post-harvest losses
   - Losses:
     Rice: 10-37 per cent
     Corn: 30 per cent

e) Increases value added of farm products
   - Secondary and tertiary processing opens up market potential and leads to higher retail prices

f) Employment and livelihood generation
- Machines designed to increase cropping intensities and production will correspondingly increase labour requirements for production and post-harvest operations
- Machines designed to diversify farm products and by-products open up various livelihood opportunities
- Use of machines requires repair shops to be established in village areas

g) Import substitution
- Local agricultural machinery manufacturing minimizes the importation of agricultural machinery

h) Export possibilities
- Locally manufactured agricultural machinery can be exported to countries with similar farming conditions

1.4 Levels of agricultural mechanization

a) Horsepower per hectare (hp/ha)
Sum of the contribution of each of the major sources of power multiplied by its assumed hp contribution divided by the total available area (Table 1.1)

Table 1.1 Level of mechanization in selected countries

Country	Level of mechanization (hp/ha)
Japan	18.87 (2011)
Korea	9.38 (2011)
China	8.42 (2012)
Thailand	4.20 (2009)
Philippines	2.31 (2011) for all crops 1.23 (2011) for rice and corn
India	2.22 (2011)
Bangladesh	1.46 (2008)
Viet Nam	1.20 (2010)

Source: PhillMech, 2011, as presented by Pollido, 2015

b) Per cent machine utilization (Amongo *et al.*, 2013)
Level of mechanization by type of technology (manual, human-animal power, human-machine power, combination of types of technology), by type of farm operation

$$= \frac{\text{Number of farmers using (type of) technology}}{\text{Total no. of farmers responding}} \times 100$$

Per cent utilization of farmers (Table 1.2)

Table 1.2 Level of mechanization by farm operations

Farm Operation	Level of Mechanization (% Utilization of Farmer)			
	Manually Operated			
	Camarines Sur (Region V)	Iloilo (Region VI)	Leyte (Region VIII)	Oriental Mindoro (Region IV)
Dike repair	93.75	78.95	88.04	86.32
Planting	100.00	100.00	98.91	98.95
Fertilizer application	100.00	100.00	97.83	100.00
Insecticide application	91.67	74.74	91.30	78.95
Herbicide application	85.42	95.79	35.87[a]	96.84
Harvesting	100.00	98.95	100.00	89.47
Drying	63.64	53.68	78.26	44.21[a]
				Animal powered
Ploughing	15.63[a]	12.63[a]	59.78	6.32[a]
Levelling	61.46	49.47[a]	88.04	55.79
				Person-machine powered
Ploughing	73.96	72.63	29.35[a]	61.05
Harrowing	67.71	80.00	84.78	55.79
Threshing/Bagging	86.46	92.63	92.39	89.47
Milling	56.25	32.63[a]	79.35	No data

Note: [a] Per cent utilization of the available power is not predominant.

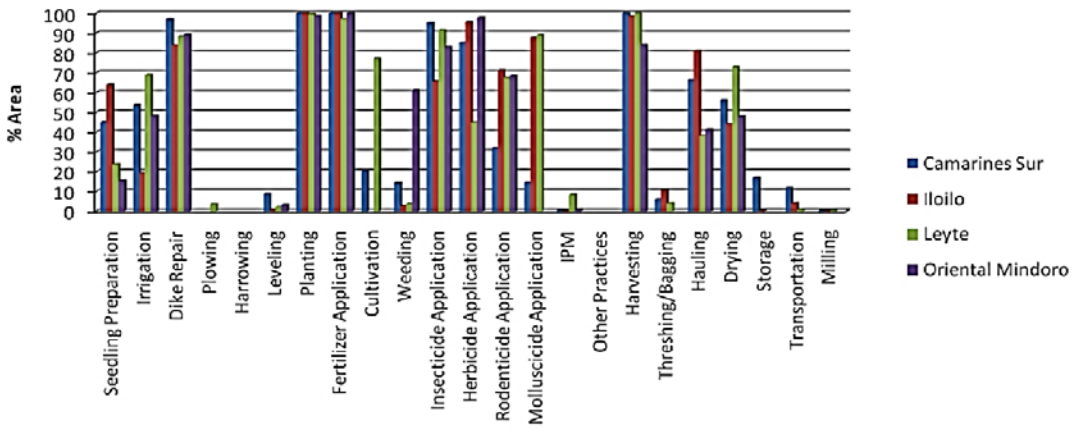
Source: Amongo *et al.*, 2013

c) Per cent area covered (Amongo *et al.*, 2013)

Level of mechanization by type of technology (manual, man-animal power, man-machine power, combination of types of technology), by type of farm operation (Figure 1.1)

$$= \frac{\text{Area serviced by (type of) technology}}{\text{Total area of farms surveyed}} \times 100$$

Figure 1.1 Per cent area covered



Source: Amongo *et al*., 2013

d) Three major levels (UPLB-BAR, 2001):

- *Low mechanization* means that an operation is done with the use of non-mechanical power source such as people and animals.
- *Intermediate mechanization* refers to operations done with the use of non-mechanical power source in combination with the use of a mechanical power source operated by a person.
- *High mechanization* involves operations done solely with the use of mechanical power source operated by a person.

These three levels are further subdivided into three sublevels indicating advancement in technology through process and strength of the power source (see Table 1.3).

A fourth, albeit minor, level is *full mechanization* wherein the operations are done with the use of a mechanical power source with limited human intervention, such as computerized machines or robots.

Table 1.3 Levels of mechanization

Operation	Rice and corn	Vegetables legumes and root crops	Coconut	Sugar cane	Fruits	Fibre crops
Land Prep	Intermediate to High	Low		Intermediate to High	Low	Low
Planting/ Transplanting	Low	Low	Low	Low to Intermediate	Low	Low
Crop care cultivation	Low	Low	Low	Low to High	Low	Low
Harvesting	Low	Low	Low	Low		Low
Threshing/shelling dehusking	Intermediate to High	Low (legumes)	Low			
Cleaning		Low				
Drying	Low	Low (legumes and root crops)	Low			Low
Milling/village-level processing	High	Low	Low		Low	Low

Source: UPLB-BAR, 2001

e) Number of tractors per hectare: Some countries, especially developed countries, currently express the level of mechanization based on the number of tractors utilized in a given unit area.

2 Custom Hiring Services of Agricultural Mechanization Technologies

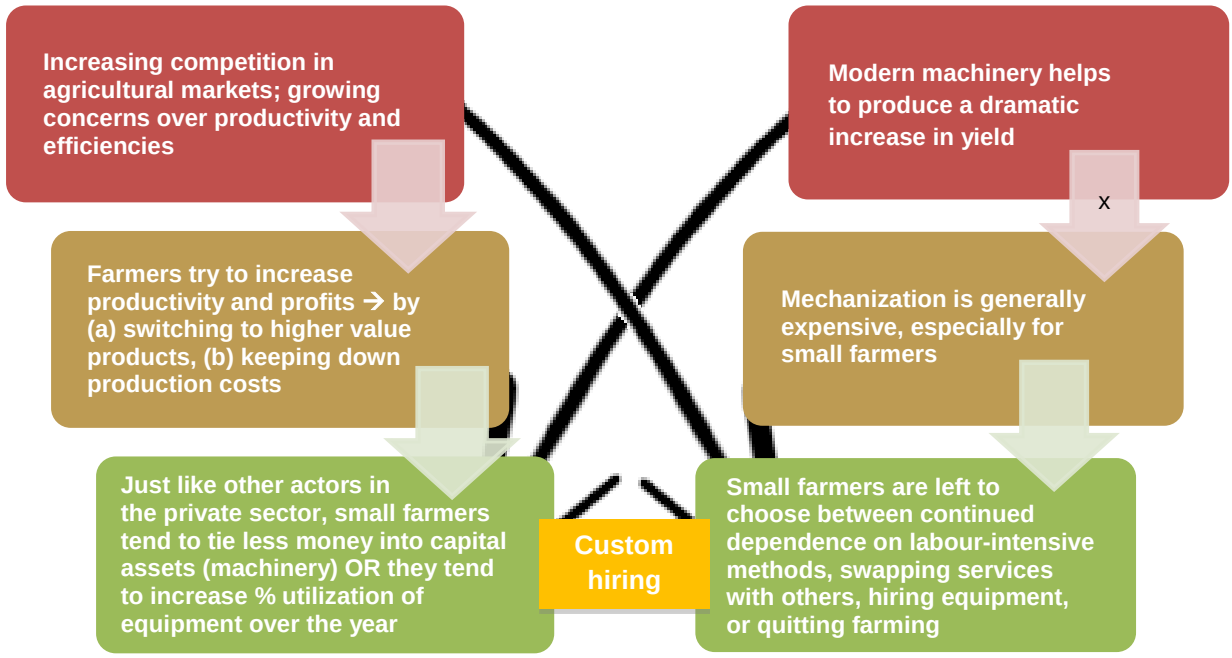
Custom hiring services for agricultural mechanization technologies (CHS for AMTs) should be operated as business enterprises that provide the following services:

- After-sales service and warranty for their respective clients
- Custom ploughing, harrowing, harvesting, drying, milling and other farm mechanization services
- Repair and troubleshooting services of agricultural and fishery machinery and equipment
- Training in maintenance and proper use of agricultural machineries and equipment

2.1 Motivation and challenges

a) Why custom hiring?

Figure 2.1 Why custom hiring?



Custom hiring enables farmers to rent the appropriate equipment, often along with someone to operate it, for a defined period of time only, thus only paying for the services of the machine without having to own it.

b) Motivation: push factors

- *Growing scarcity of labour* in agrifood systems
- *Increasing labour costs*
- *Lack of financial and technical capacity*: new technologies are economically and technically out of the reach of smallholders (to buy at their own); they are either very expensive or require advance operating skills
- Climate change has shortened the "window" for completing critical agricultural operations, requiring increased use of machines to ensure timeliness
- *Increased accessibility*: resource-poor farmers can access up-to-date agricultural machinery, which is otherwise economically and technically out of reach
- *Faster uptake of new technologies and machines*: opportunity to make a lower investment in machinery and have latest technologies whenever needed
- Increased chance that machinery is modern and in good operating condition, reducing time spent on breakdowns
- *Specialized agricultural operations*: more highly skilled and higher-quality operators
- *Expansion and intensification of production*: prospects for rapid increase in mechanization level
- Better access to *repair and maintenance (R&M) services*
- Greater *rural entrepreneurship* development
- *Increasing smallholders' incomes*: enhancing technical and economic efficiency across the value chain
- Facilitating the *organization and implementation of subsidies* and other incentive policies
- *Utilization of machine's full service life*: every machine will be used by more farmers and renewed earlier – after fullest (potential) use during its service life
- Facilitation of *diversification of production*
- *Costs more predictable*: through reduced risks for unexpected costs of R&M
- *Costs of machinery can be drawn from operating capital*, as there is no long-term investment involved

c) Challenges

- *Not having enough service providers*: due to competing demands (e.g. during small window of harvest period the machinery (and/or its operator) may not be available at time desired by farmer leading to a potential loss in harvest
- Farmers *lack full control* over the job performed

d) Enabling environment is critical for the custom-hiring suppliers

- Government commitment with a clear sustainable agricultural mechanization strategy
- Suitable regulatory framework, and support policies to attract private sector investment
- Financial mechanisms and incentives for both the users and service providers
- Land-tenure policies
- Infrastructural support base to facilitate use of machinery

Figure 2.2 Suppliers of custom hiring (CH) services

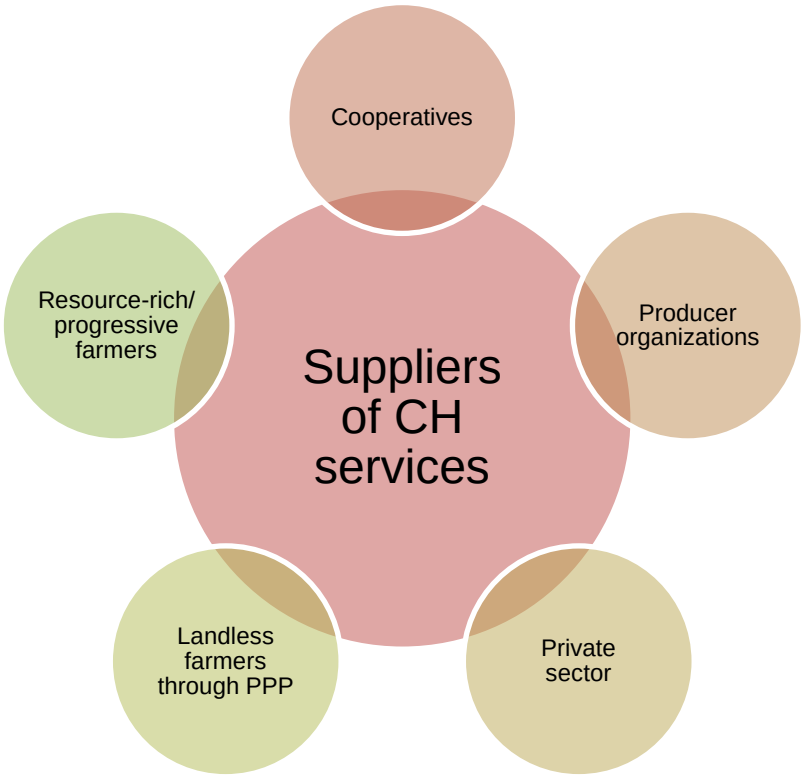
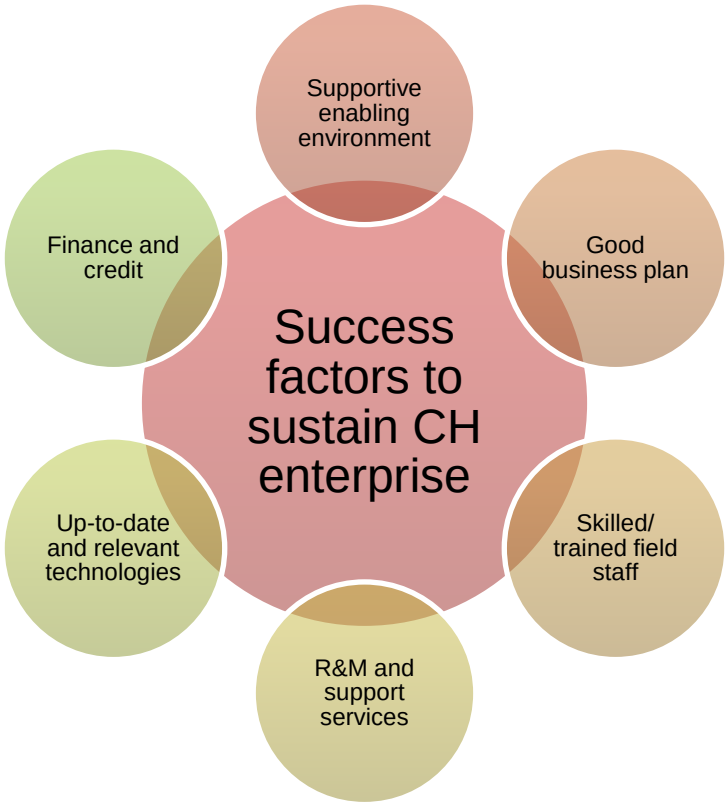


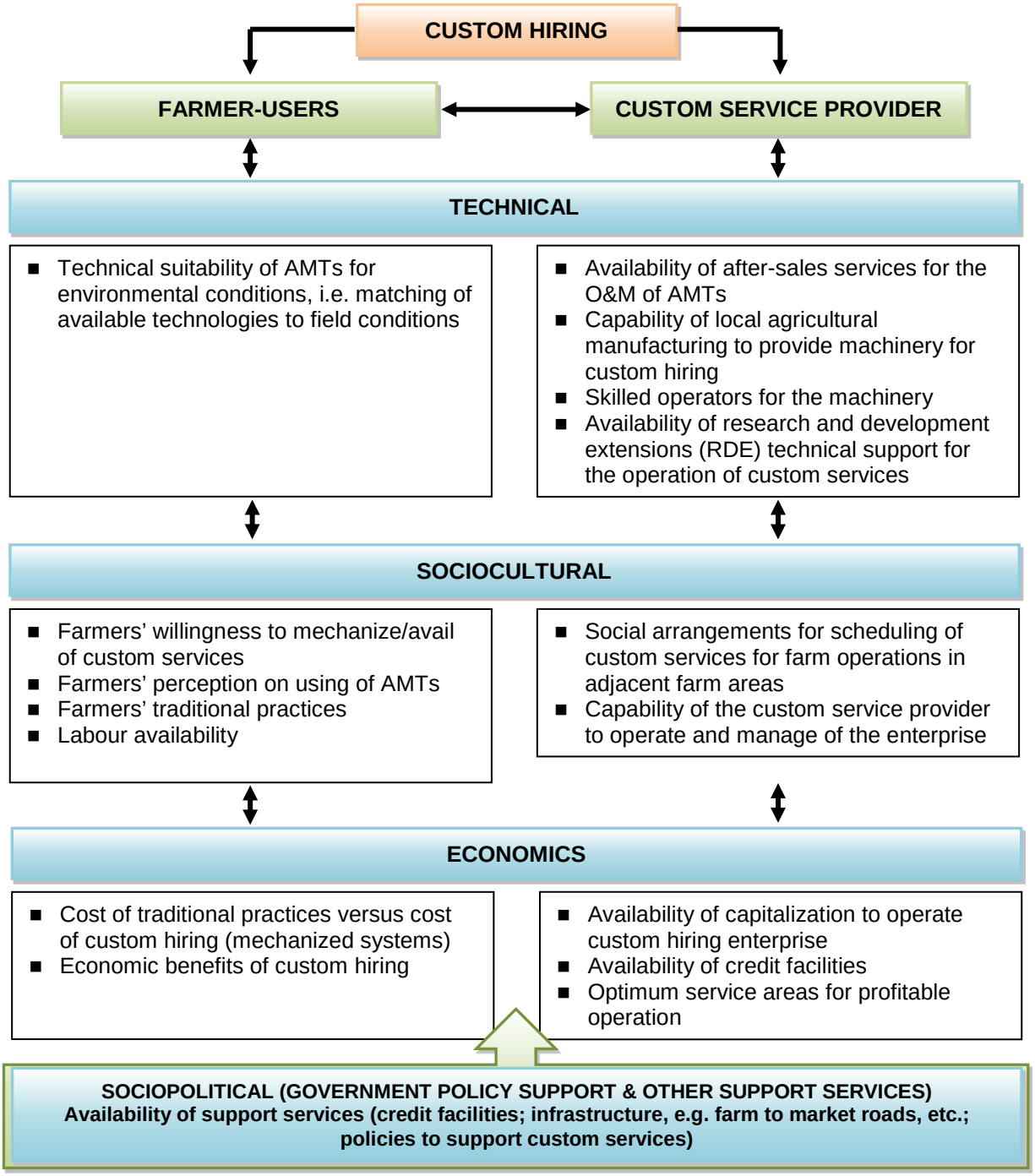
Figure 2.3 Success factors to sustain custom hiring (CH) enterprises



Often, an operator of the machinery will also be included in rental. The tariff may be charged by the hour, or, in some cases, by area harvested. Usually, the owner of the machinery is responsible for maintenance and major repairs; farmers are only responsible for minor repairs in the field.

2.2 Conceptual framework

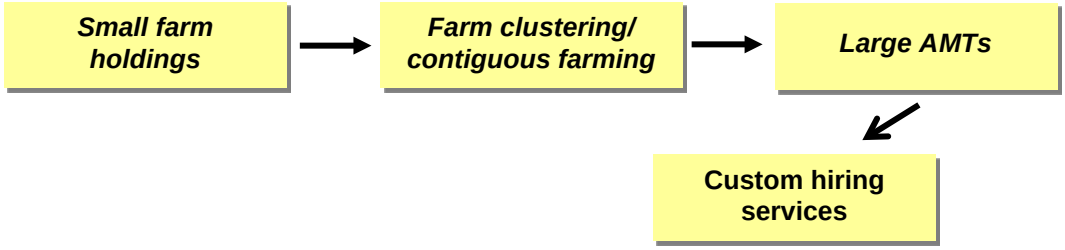
Figure 2.4 Conceptual framework for custom hiring services of agricultural mechanization technologies



Source: Amongo and Larona, 2014

a) Farmers as beneficiaries of custom services

- Technical suitability of agricultural machines：location specificity of AMTs
- Farm size



- Farmers' traditional practices: social preparation
- Farmers' preferences on use of agricultural machines

  Operations which farmers would like to mechanize (Amongo, 2013)
  - land preparation
  - planting
  - harvesting
  - drying

  Ownership of large agricultural machines was low; farmers opted for hiring agricultural machines rather than owning the machines.

- Labour availability

  Social issues in establishing custom services: possible displacement of farm labour.

  Lantin *et al*. (2003) noted that agriculture should not be viewed as a sink for employment since the gains that could be generated from farming activities (such as farm labour) are not enough to improve the quality of life of landless farm workers.

  Other alternative income opportunities: establishment of agro-processing enterprises, training opportunities for possible employment in urban areas.

- Cost of mechanized system versus traditional practices

  Major reasons that corn farmers joined clustering and custom services facilities in Cauayan City, Isabela, Philippines:
  - reduction in production cost
  - improved production performance
  - availability of support services from the government
  - increase farm operation efficiency.

  Net income for a fully mechanized system = PhP 22,210/ha
  Net income for traditional system = PhP13,045/ha

  Source: Larona (2006)

b) Custom service provider

- Technical suitability of agricultural machines

  Location specificity of AMTs

  Locally fabricated AMTs versus imported AMTs

- Availability of after-sales services
  - Training on operational risk management
  - Availability of spare parts

- Local manufacturing
  - Available small- to medium-scale manufacturers

- Social arrangements for scheduling of custom services
  - Synchronize farming

- Operation and management of custom services
  - Machinery pooling versus custom services

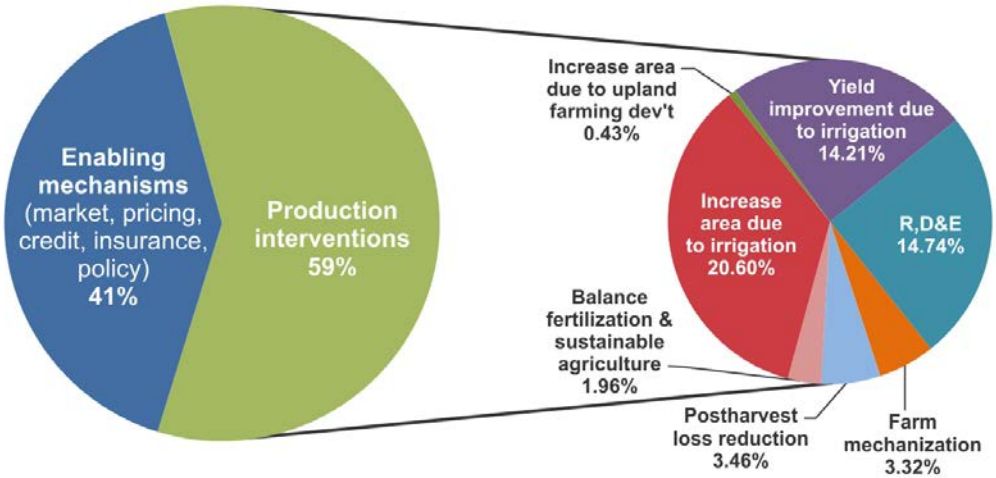
2.3 Enabling environment for CHS of AMTs

Table 2.1 Labour cost for land preparation, crop establishment, harvesting and threshing (based on key informant interviews of selected Asian countries, 2012)

Province, country	Labour cost for land preparation, crop establishment, harvesting, and threshing (in USD/ha)
Nueva Ecija, Philippines	484.50
Zhejiang, China	533.00
Tamil Nadu, India	268.00
West Java, Indonesia	430.50
Suphan Buri, Thailand	192.00
Can Tho, Viet Nam	198.00
Zhejiang, China	484.50

Source: Regalado, 2015

Figure 2.5 Increase in production



Source: Regalado, 2015

Figure 2.6 Enabling environment for custom hiring services of AMTs

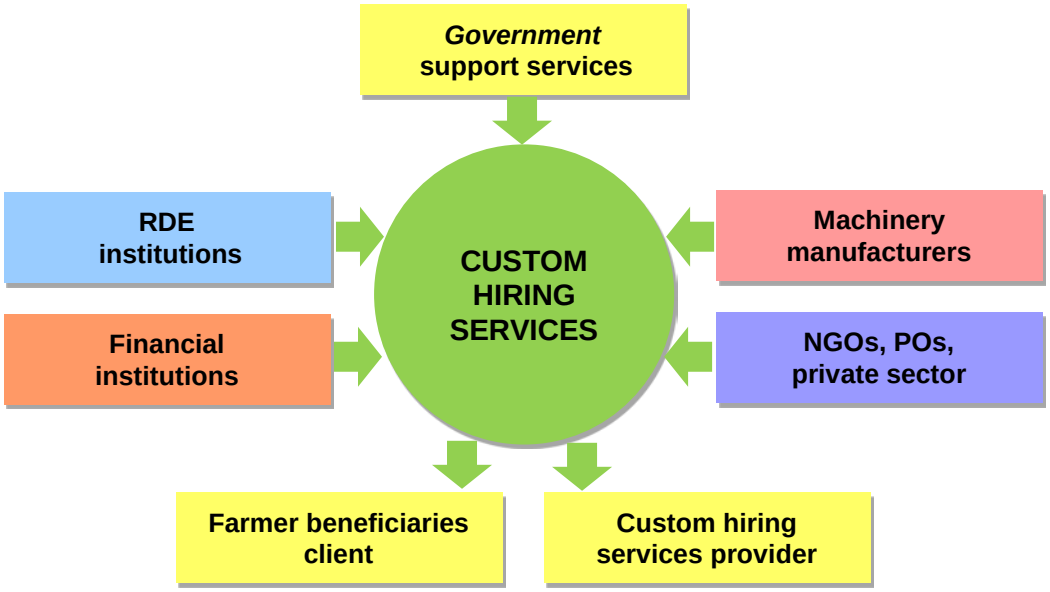


Table 2.2 Government support services in selected Asian countries

ITEMS	PROVINCE, COUNTRY					
	Nueva Ecija, Philippines	Zhejiang, China	Tamil Nadu, India	West Java, Indonesia	Suphan Buri, Thailand	Can Tho, Viet Nam
Seed subsidy	No subsidy	Free inbred seeds; free hybrid seeds only to cooperative members	USD 0.2 subsidy per kg of seeds	USD 0.91 subsidy per kg of seeds	No subsidy	No subsidy
Price of urea	USD 27.91 per bag	USD 20.83 per bag	USD 5 per bag (subsidized)	USD 9.10 per bag (subsidized)	USD 24.38 per bag	USD 26.43 per bag
Irrigation/ water	USD 49 /ha (wet season); USD 69 /ha (dry season);irrigation fee is free if crop is damaged	Free	Free	Free	Free	Free
Land tax	USD 28/ha/ year	Free	USD 0.21/ha/ year	USD 56 /ha/year	USD 0.98/ha/ year	Free
Interest on Credit	24% per annum from cooperatives	5% per annum but govt. pays for 80% (4% is paid by the govt. and 1% is paid by the farmer)	0% interest if loan from govt. bank is paid within 6 months	12% per annum from govt. bank	6% per annum from Bank of Agriculture	12% per annum in AgriBank

ITEMS	PROVINCE, COUNTRY					
	Nueva Ecija, Philippines	Zhejiang, China	Tamil Nadu, India	West Java, Indonesia	Suphan Buri, Thailand	Can Tho, Viet Nam
Machine Acquisition	85% discount on farm machinery and post-harvest facility for qualified irrigator's association and farmers cooperatives	30% discount on tractors and combine harvester-thresher; 50% on mechanical drier	Govt. custom hires combine leveller, mechanical transplanter and tractor at 50% lower rental rate. However, govt. can service only 2%of area	No subsidy	No subsidy	70% of the value of principal have low interest during the first year
Government paddy procurement	Govt. procures less than 5% of production at a support price	Govt. procures inbred rice production. Govt. offers protection price for inbred rice	Govt. procures around 60% of harvest. Govt. has minimum support price	Govt. does not procure paddy from farmers but from traders	Govt. procures all production at a guaranteed price	Govt. procures through state-owned companies at a price giving 30% profit margin to farmers

Source: Regalado, 2015

a) Land consolidation (contiguous farming)

RA 10601 Agriculture and Fishery Mechanization Act of 2013 (IRR- Section 3- Rule 3.1):

"Contiguous farming – shall be defined as a farming system comprising the development and organization of parcels of adjoining or adjacent agricultural lands with a minimum total area of 50-ha for the synchronized production of a particular crop such as but not limited to rice, corn, sugarcane, coconut and high value commercial crops utilizing agricultural mechanization technology. It shall include the necessary physical and institutional infrastructures. Physical infrastructures include the overall design layout of the area (e.g. field plot size, irrigation canal, farm drain, farm ditch, farm roads, postharvest facilities, etc.), while institutional infrastructures consist of the social base by which contiguous farming scheme shall operate."

BENEFITS OF LAND CONSOLIDATION

- develops cooperation among farmers
  - for water management
  - synchronized harvesting
  - communal warehouse, post-harvest facilities, etc.
- develops market channels that demand bulk harvests
- enables efficient field operations
- improves efficient use of water and better weed control
- increases land and labour productivity
- increases crop production

Japan

Figure 2.7 Land before and after land consolidation

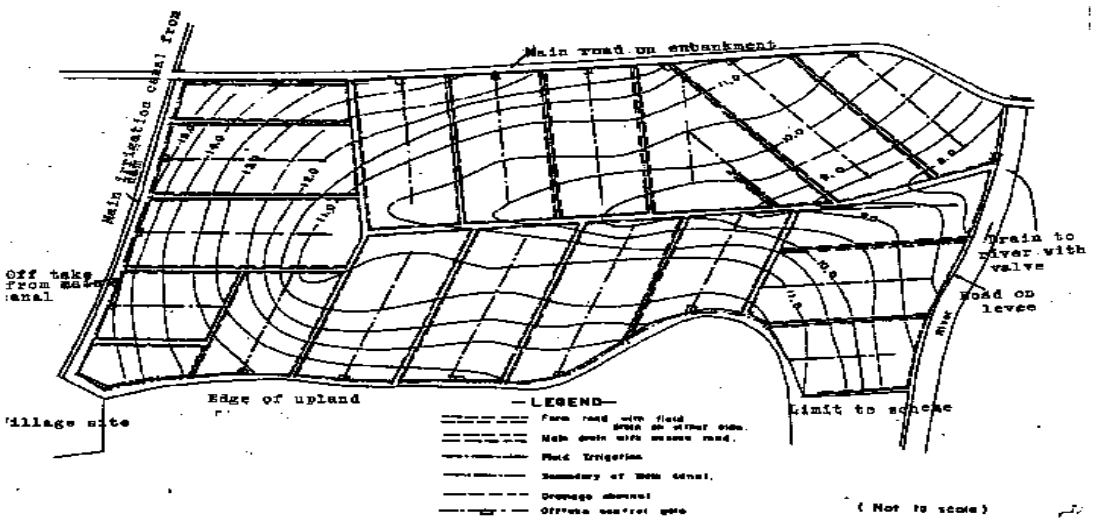
BEFORE AFTER

- Increase in large-scale farms
- Crop diversification through multipurpose use of paddies
- Increase in rice production from 4.02 to 4.5 tons/ha
- Irrigation system regulates floods
- 40 per cent overall work reduction in paddy field from 185 h/0.1 ha (1950s) to 39 h/0.1 ha (1993)
- Reduction in total human labour from 1050 h/ha to 300 h/ha

Korea

- 94-99 per cent mechanized in 1998
- Approximately 40 years taken to finalize the concept
- 5 years to implement scheme due to objections from landowners/farmers

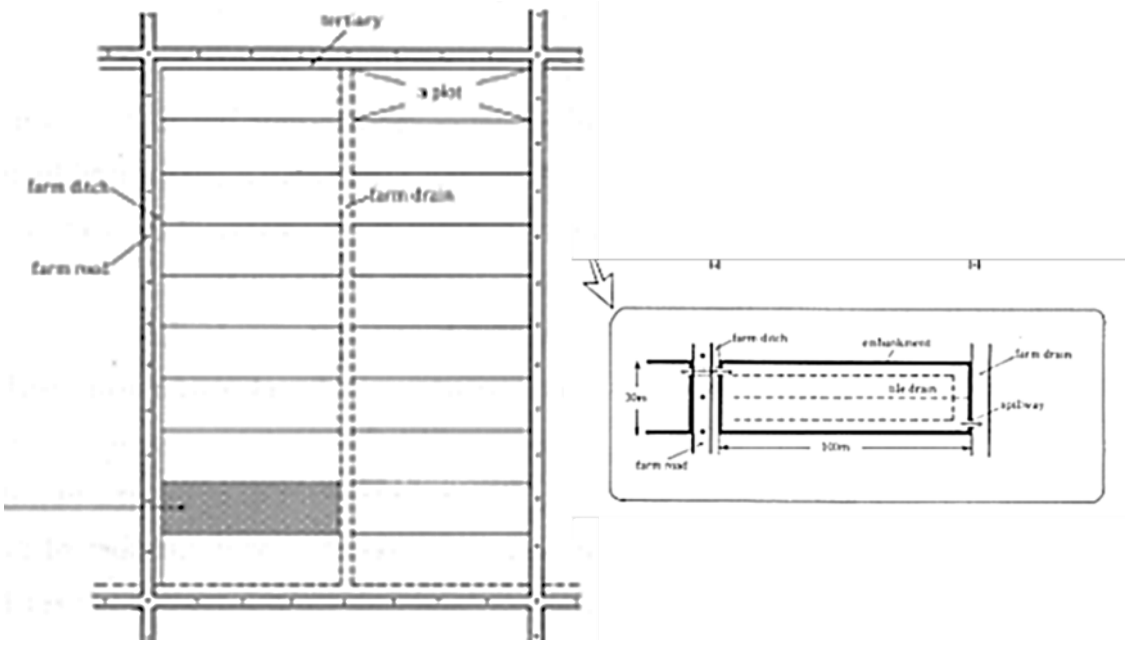
Figure 2.8 Typical layout pattern of irrigation canals and drains (Korea)



b) Phases of land consolidation

i. Farm layout

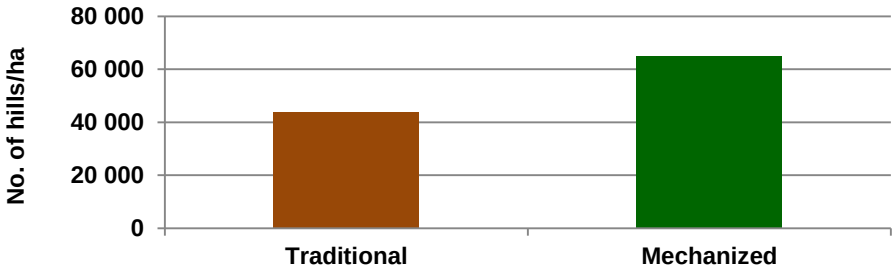
Figure 2.9 Farm layout samples



ii. Site clearing/earth moving
iii. Levelling of field
iv. Subsurface drainage works
v. Irrigation facilities
vi. Construction of farm road, farm ditch, farm drain, other construction activities
vii. Installation of power supply
viii. Construction of production and post-harvest facilities and shed

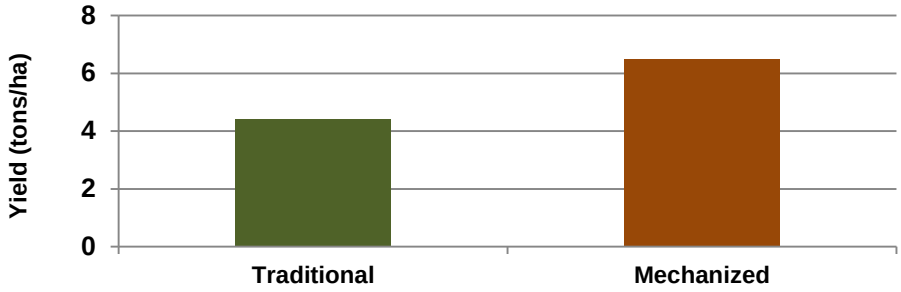
Significant accomplishments: Villa Luna Multipurpose Cooperative, Isabela Philippines (VLMPC)

Figure 2.10 Observed number of hills/ha, traditional versus mechanical methods



Source: Larona, 2006

Figure 2.11 Observed yield, traditional versus mechanized methods



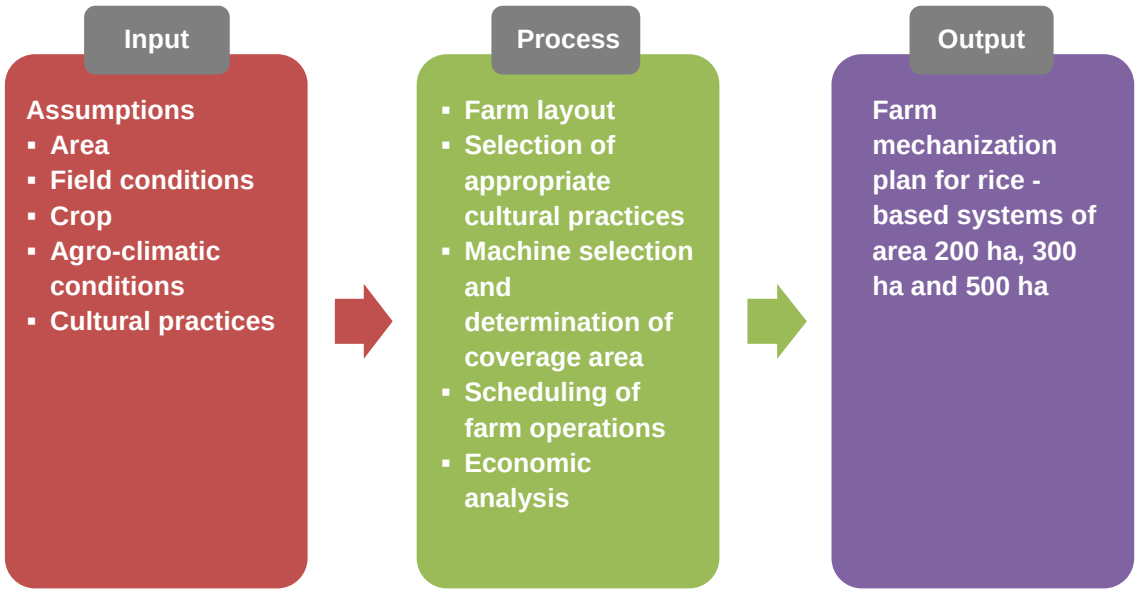
Source: Larona, 2006

3 Establishment of Custom Hiring Services

3.1 Technical aspects

a) Projections of machinery requirements

Figure 3.1 Projection sample for a rice-based system



b) Cropping calendar

Figure 3.2 Rice variety of PSB Rc82 growth duration

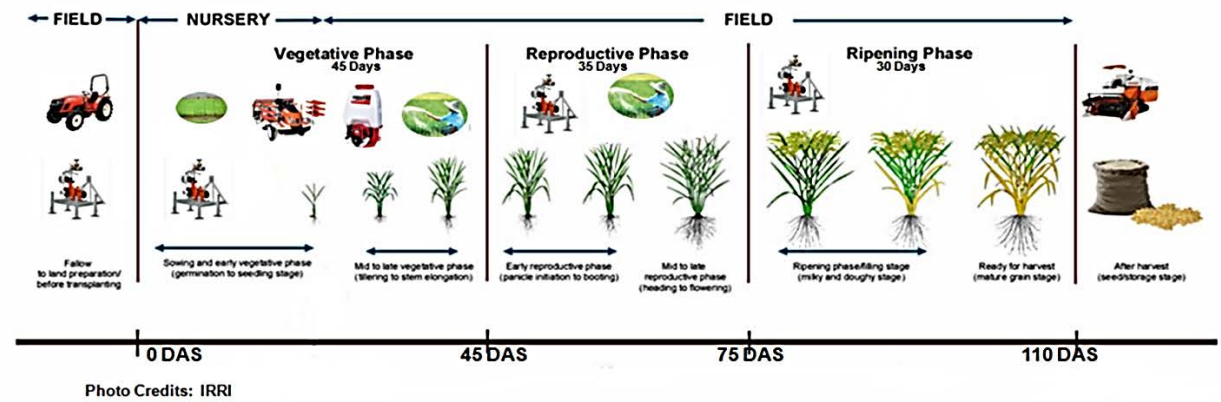


Table 3.1 Rice cropping pattern in four provinces

OPERATION	CAM. SUR		ILOILO		LEYTE		OR. MINDORO	
	Duration	Available workdays	Duration	Available workdays	Duration	Available workdays	Duration	Available workdays
Seedling Prep.	Nov 15 - Nov 30	12	May 16 - May 31	13	Nov 9 - Nov 30	18	May 12 - May 31	16
Land Prep.	Nov 14 - Nov 30	13	May 14 - May 31	15	Nov 8 - Nov 30	19	May 11 - May 31	17
Planting	*Dec 1 - Dec 31	25	*June 1 - June 30	24	*Dec 1 - Dec 31	25	*June 1 - June 30	24
Chem. App.	Dec 8 - Jan 13	28	June 9 - July 15	29	Dec 12 - Jan 5	20	June 6 - July 5	24
Harvesting	Mar 1 - Mar 31	25	Sep 3 - Sep 27	20	Feb 23 - Mar 31	30	Sep 18 - Oct 17	24
Threshing	Mar 1 - Mar 31	25	Sep 3 - Sep 27	20	Feb 23 - Mar 31	30	Sep 18 - Oct 17	24
Drying	Mar 2 - Apr 5	28	Sep 4 - Sep 28	20	Feb 25 - May 2	30	Sep 19 - Oct 7	16

Source: Amongo *et al*., 2013

Table 3.2 Rice mechanization technology coverage area in four provinces

MACHINE	OPERATION	CAM. SUR		ILOILO		LEYTE		OR. MINDORO	
		Coverage area	No. of units	Coverage area	No. of units	Coverage area	No. of units	Coverage area	No. of units
Two-wheel tractor	Seedling prep.	6.93	-	7.51	-	7.80	-	11.55	-
	Land prep.	11.26	22	12.99	19	16.46	13	14.72	19
Four-wheel tractor	Land prep.	23.40	11	27.00	9	34.20	7	30.60	9
Engine-powered transplanter	Transplanting	18.90	13	18.14	14	18.90	11	18.14	15
Rice drum seeder	Broadcasting	18.75	14	18.00	14	18.75	11	18.00	16
Engine-powered sprayer	Chemical application	24.53	10	25.40	10	17.52	12	21.02	13
Combine harvester	Harvesting	72.60	4	58.08	5	87.12	3	69.70	4
Thresher	Threshing	81.82	3	68.90	4	97.85	3	69.10	4
Dryer	Drying	15.13	17	11.38	18	16.16	13	7.61	36

Source: Amongo *et al.,* 2013

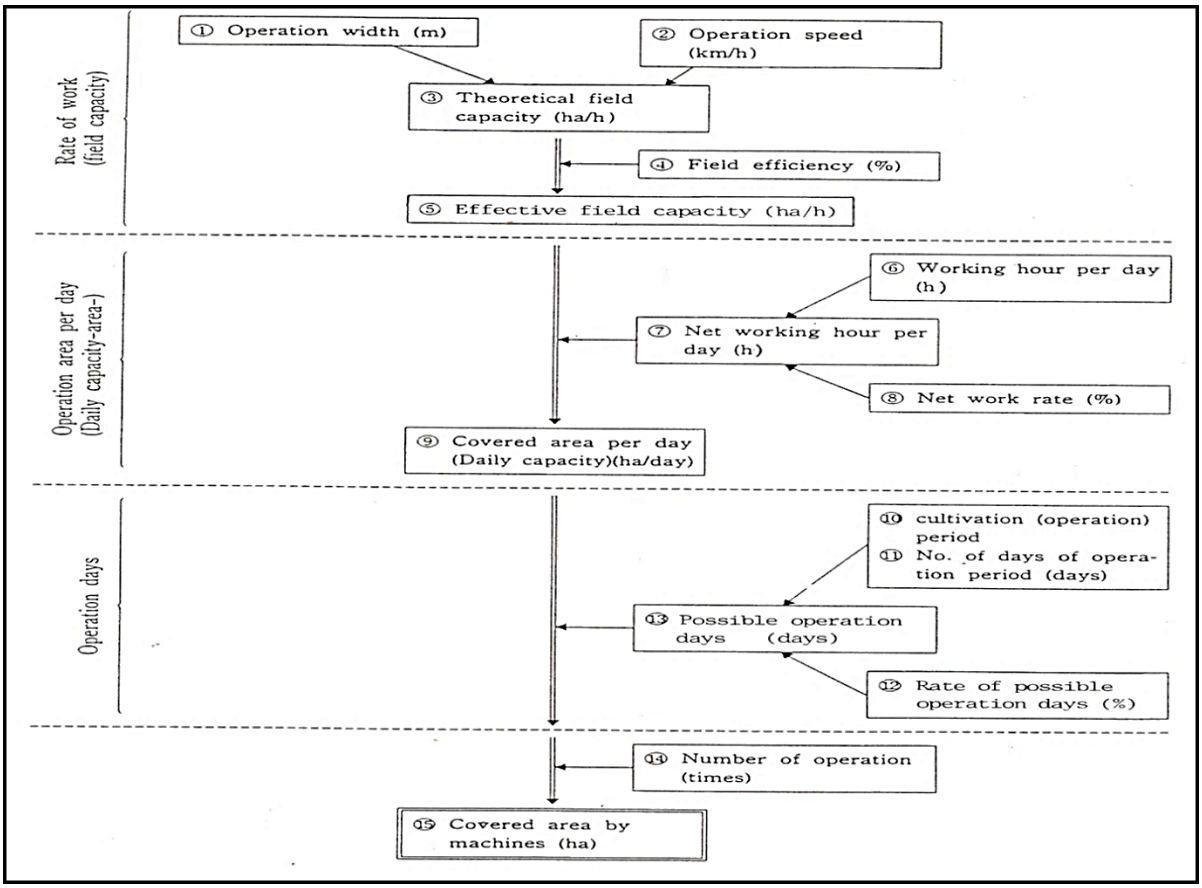
Table 3.3 Projected volume of rice mechanization technologies in four provinces

MACHINE	OPERATIONS TO BE MECHANIZED	Projected no. of machines for the province				
		CAMARINES SUR	ILOILO	LEYTE	ORIENTAL MINDORO	Weighted average
Two-wheel tractor	Land prep.	10 780	14 867	3 287	5 774	8 184
Four-wheel tractor	Land prep.	5 188	7 154	1 582	2 779	3 938
Four-wheel tractor	Transplanting	6 423	10 646	2 862	4 686	6 123
Engine-powered transplanter	Broadcasting	6 474	10 731	2 885	4 724	6 172
Rice drum seeder	Chem. App.	4 949	7 604	3 088	4 044	5 128
Engine-powered sprayer	Harvesting	1 672	3 326	621	1 220	1 578
Combine harvester	Threshing	1 484	2 804	553	1 231	1 429
Thresher	Drying	8 021	16 974	3 348	11 176	9 023

Source: Amongo, *et al.,* 2013

c) Rice mechanization technologies

Figure 3.3 Rice mechanization considerations



Source: JICA-TBIC, 2001

Table 3.4 Operation speed in rice mechanization by operations

Name of operation	Equipment	Operation speed (km/h)			Remarks
		Low	Standard	High	
Sowing and fertilizing	Snapsack power duster	0.8	1.2	1.6	Use granule blow head
Pest and disease control	Knapsack power applicator	0.8	1.2	1.6	Duster application (boom type blow head)
		1.0	1.2	1.4	Duster application (single blow head)
		1.1	1.4	1.6	Granule blow head
		0.7	0.9	1.1	Mist blower
	Power sprayer	2.0	2.7	3.4	Horizontal type nozzle
		1.5	2.1	2.6	Swath nozzle
	Power duster	1.1	1.6	2.0	Manual operated type (boom type blow head)
		1.8	2.2	2.5	Pull-type (boom type blow head)
		1.6	2.0	2.3	Mount type (boom type blow head)
	Manual-type granule applicator	1.8	2.3	2.9	
Harvesting by reaping and binding	Binder	2.0	2.6	3.3	One row type
		1.8	2.2	2.7	Two row type
Harvesting and threshing	Head-feeding type combine harvester	1.2	1.6	2.1	0.5-0.7 m cutting width
		1.0	1.4	1.8	0.9-1.3 m cutting width
	Standard combine harvester	0.7	1.2	1.6	1.5-2.4 m cutting width
		0.7	1.3	2.0	3.0 m cutting width
		1.0	1.5	2.5	4.7 m cutting width

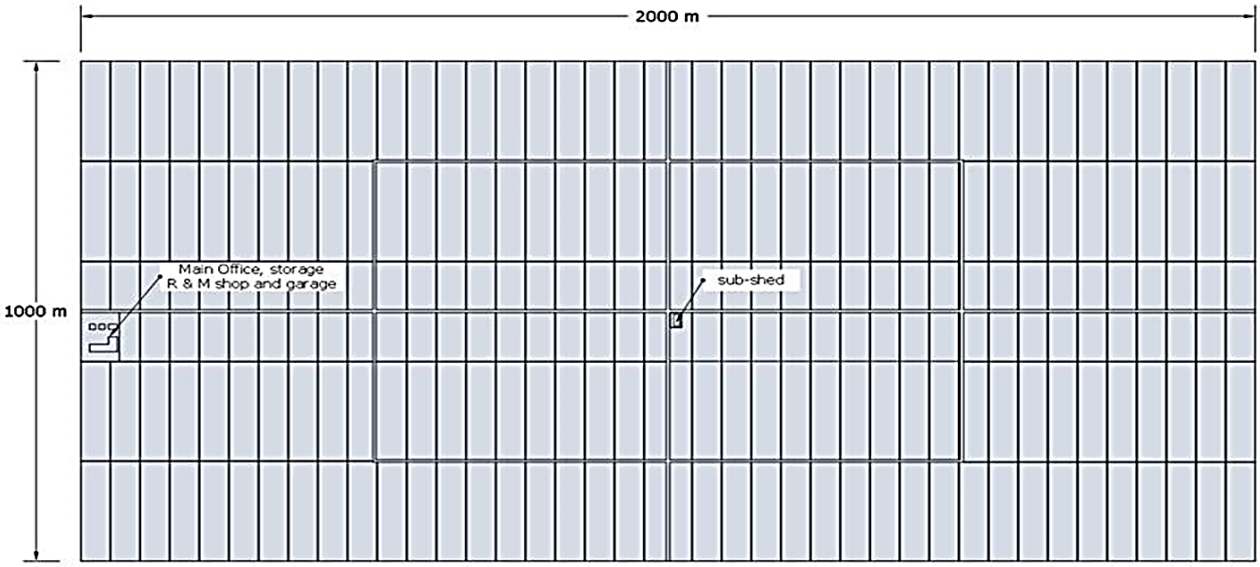
Source: JICA-TBIC, 2001

Table 3.5 Field efficiency in rice mechanization by work

Name of works	Equipment	Field efficiency (%)			Remarks
		Low	Standard	High	
Ploughing	Suki for hand tractor	75	84	94	Pull and dual type power tiller
	Bottom plough	50	62	73	Including suki with tractor
	Rotary tiller	82	89	96	Dual and power driven power filler
		64	75	86	Above 15ps tractor
Ploughing and pulverizing	Plough with pulverizer	50	62	73	High-cut plough, rotary plough, etc.
Pan-breaking	Subsoiler	30	35	40	
Pulverizing (harrowing)	Rotary and tiller	82	89	96	Dual and power driven power tiller
		70	82	94	Above 15 ps tractor
	Disc harrow	65	70	75	
Levelling	Tooth harrow	70	80	90	
Pressing	Roller	60	65	70	Including culti-packer
Puddling	Paddy harrow	70	82	94	Rotary and levelling plate
Transplanting	Rice transplanter with young seedling	33	54	74	Manual one-row type
		37	55	74	Power-driven two-row type
	Rice transplanter with large seedling	39	56	73	Power-driven two-row type
Fertilizing	Manure spreader	20	30	40	Including the feeding and transporting
	Lime sower	40	50	60	
	Broad-caster	45	55	65	
Sowing and fertilizing	Grain drill (drill seeder)	54	65	76	Power driven (working type)
		30	45	60	Direct-mounted type
		38	52	66	Traction type
Pest and disease control	Knapsack-type power duster	35	50	65	Dusting
	Power sprayer	35	50	65	Using horizontal nozzle
		24	35	46	Using swath nozzle
	Power ductor	35	50	65	
	Hand sprayer	37	54	71	
Reaping and binding	Reaper binder	47	65	83	
Threshing	Self-propelled power thresher	47	65	83	
Harvesting and threshing	Head-feeding combine	34	50	66	Including harvesting by hand in corner
		51	65	79	Not including hand harvesting
	Standard-type combine	43	55	66	

Source: JICA-TBIC, 2001

Figure 3.4 Farm to market roads



Source: Ruzgal *et al*., 2014

Size of farm roads should be based on the type of machine and PAES 421

d) Machinery coverage determination: condition of farm area

- Field condition:
  Lowland field – flooded condition, transplanted
  Upland field – dry, unbunded, directly seeded
  Machinery utilization depends on the condition of the field/farm

Table 3.6 Soil hardness estimation using human foot

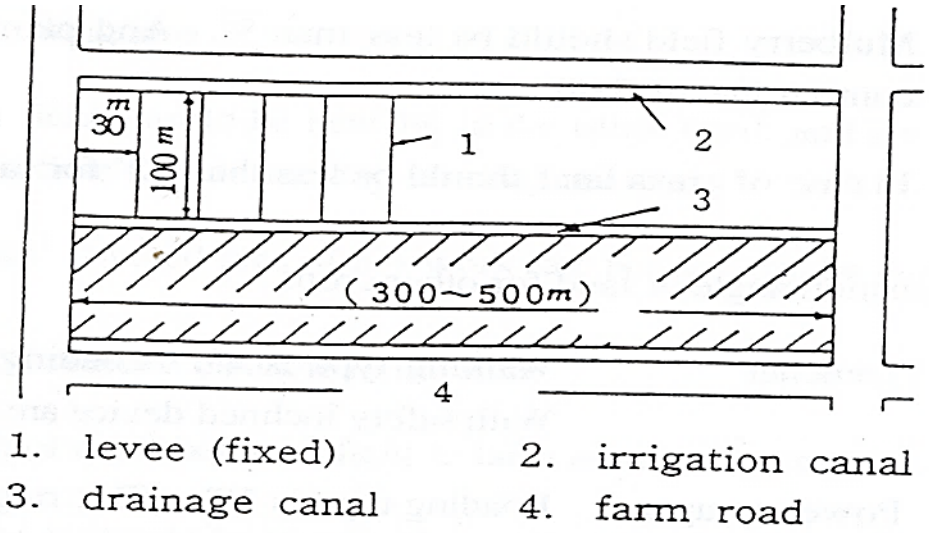
Standard judgement	Tractor with attachments			Combine (minimum height from ground)		
	Rotary	Bottom plough	Bottom plough with girdle	< 10 cm	10-20 cm	>20cm
Limits of ease of operation	< 2 cm	0	< 1 cm	< 2 cm	< 3 cm	< 4 cm
Limits of possible operation	2-5 cm	0-2 cm	1-5 cm	2-5 cm	3-7 cm	4-10 cm
Limits of impossible operation	> 5 cm	> 2 cm	> 5 cm	> 5 cm	> 7 cm	> 10 cm

Source: JICA, 2001

- Hard pan and soil moisture
  Mechanized operation in lowland field condition requires the presence of hardpan

- Size and shape of field: preferably rectangular in shape

Figure 3.5 Sample field



- Inclination of field
  In case of contour line operation in upland field: ridging – 6°
  broadcasting, flat ridging or standard cultivation – 10°
  operation of maximum contour line direction – 10°

- Inclination of field for other crops
  Combine:
  operation along the contour line - 3°
  maximum inclined direction - < 5°

Table 3.7 Length of headland

Kind of machine		Length of headland
Tractor	Fruit garden	About 4 m
	Mulberry garden	2-3 m
Trencher	Self-propelled type (walking type)	About 2 m
	Loading type	About 5 m
	Self-propelled type (riding type)	About 5 m
Power sprayer	Loading type	3.5 m
	Pulling type	4.5 m
	Self-propelled type	4.0 m

Source: JICA, 2001

Table 3.8 Farming area measurements

Paddy field	Height between paddy field to road	(1) 30 cm: tractor (2) < 20 cm: head-feeding combine (cutting width 0.8~1.2 m) < 25 cm: combine (cutting width 1.2~3.5 m) < 40 cm: combine (<3.5 m cutting width)
	Go into field from road	(1) In case, if there is more than 30 cm height between paddy field to farm road, and also there are canal between paddy field to farm road, the width should be more than tractor or equipment width, and inclined angle should be less than 12 degree
Upland field	Inclination angle	< 8~10º
	Radius of curvature	> 6 m
	Headland	If farm road used for headland, the width of farm road should be more than 3.5 m

Source: JICA, 2001

Table 3.9 Machinery coverage determination

FARM OPERATION	AGRICULTURAL EQUIPMENT AND MACHINERY	FIELD CAPACITY					DAILY COVERED AREA			
		Working width (m)	Operating speed (kph)	Theoretical field capacity (ha/hr)	Field efficiency (%)	Actual field capacity (ha/hr)	Working hours per day (h)	New work rate (%)	Net working hours (hr/day)	Daily capacity (ha/day)
Land preparation	Four-wheel tractor	-	-	-	-	-	-	-	-	-
	Disc plough	1.0	5.0							
	Rotary tiller (first pass)	1.6	5.0							
	Rotary tiller (second pass)	1.6	6.0							
Transplanter	Self-propelled rice transplanter	1.8	5.0							
Crop protection	Knapsack power sprayer	8.0	1.2							
Harvesting and threshing	Combine harvester	1.9	4.4							

3.2 Economics of agricultural machinery

Economics play a vital role in agricultural machinery management. Selection of the size and capacity of a machine for a particular job requires careful evaluation of all cost items. Oversized machines require higher investment and may be too large for economic operation with the rest of the machines in the farm (Hunt, 1983). Undersized machines may give a lower investment but the increased labour cost may offset the savings. The machine that gives the lowest investment and operating costs is recommended.

The final decision is influenced by the following:

- suitability of the machine for the crop, field and weather conditions
- timeliness of field operation, which is governed by the capacity of the machine
- capital available
- cost and availability of labour and fuel.

a) Benefits and costs of agricultural machinery operation
Costs can be grouped into two categories:

- **Fixed costs** are expenses incurred regardless of whether the machine is operated or not:
  - depreciation
  - interest on investment
  - shelter
  - taxes and insurance
  - repair & maintenance.

i. Depreciation (D) is the reduction in the value of the machine as a result of use (wear and tear) and obsolescence (availability of newer and better model).
Straight-line method:

$$D = \frac{\text{Initial cost - Salvage value}}{\text{Useful life}} = \frac{IC - SV}{L} \quad \text{eqn. 1}$$

where:
SV = salvage value of the machine at the end of useful life usually estimated at zero to 10 per cent of initial cost
L = useful life based on experience and similar machines

ii. Interest on investment (IOI) is the charge for the use of the money invested on the machine regardless of whether the money was borrowed or not.

$$IOI = \frac{(IC + SV)}{2} X\, r \quad \text{eqn. 2}$$

where
r = interest rate
= bank interest rate on agricultural loans

iii. Shelter is provided to protect the machinery from theft and adverse weather conditions, to make repair work easier and to improve the appearance of the farm. Included in the computation of depreciation, IOI, insurance, and repair and maintenance.

iv. Insurance is the cost of protecting the machine and shelter against accidents and theft.

v. Repair and maintenance costs are fixed allowances provided for the repair of machine and shelter. Usually estimated at 10 per cent of initial cost.

vi. Taxes are sometimes collected in some places when the machine has to be registered with the local government.

- **Variable costs** are expenses incurred as a result of machine operation:
  - power costs
  - labour
  - other inputs.

b) Project appraisal

Project appraisal provides a comprehensive review of all aspects of the project. It includes economic and financial analysis, including analysis of economic soundness of the project, quantification and valuation of costs and benefits and ensuring financial viability.

The methods most often used for evaluating a project (Sarma, 2010) are:

- Simple rate of return (SRR)
- Payback period (PBP)
- Break-even point (BEP)
- Benefit-cost ratio (BCR)
- Net present value (NVP) or net present worth (NPW)
- Internal rate of return (IRR).

- Undiscounted measures of project appraisal do not take into consideration the change in the value of money over time.
  i.e. SRR, PBP and BEP
- Discounted measures of project appraisal take into account the time value of money through the process of discounting.
  i.e. BCR, NVP and IRR

i. Undiscounted measures of project worth

- **Simple rate of return (SRR)** is a commonly used criterion for project evaluation. It basically expresses the average net profits (Net Cash Flows) generated each year by an investment as a percentage of investment over the investment's expected life

$$SRR = Y/I \qquad \text{eqn. 3}$$

where:

Y = the average annual net profit (after allowing depreciation) from the investment

I = the initial investment

The calculated SRR should be compared to the investor's required rate of return (RRR) to judge the profitability of the investment. The investment will be accepted if SRR > RRR, otherwise it should be rejected. When the SRR of all the

investment opportunities is greater than the RRR of the investor, then the investment yielding the highest SRR should be selected.

- **Payback period (PBP)** is length of time it takes to recover the invested capital or until the net benefits equal the investment cost. Depreciation is not included in the computation of cost to avoid double accounting since the initial capital is included in the computation.

$$PBP = \frac{\text{Initial investment}}{\text{Avearage annual net benefits}} \qquad \text{eqn. 4}$$

where:

Ave. annual net benefits =

$$\frac{\sum_{1}^{n}(\text{Total Benefits} - \text{Total Costs})}{n}$$

n = no. of years of benefits

Individual investments are ranked according to their relative payback period with the shortest being the most favoured. The acceptability of the investment is determined by comparison with the investor's required payback period (RPP). Accept the investment when the PBP < RPP, otherwise reject the investment.

Although it is simple and easy to use, the PBP method has two major weaknesses as a measure of investment worth:
- this method fails to consider earnings after the payback period is reached
- it fails to consider the difference in timing of cash flows.

- **Break-even point (BEP)** is level of operation where it neither produces a profit nor incurs a loss.

$$AFC + VC(X) = B(X) \qquad \text{eqn. 5}$$

where
AFC = annual fixed cost
VC = unit variable cost
B = unit benefit
X = no. of units for BEP

Select an investment with BEP that has the lowest break-even point among the alternatives. An investment should be operated above the BEP to be economical.

ii. Discounted measures of project worth

Discounting is a process of translating future values in present worth by applying a set of discount factors.

$$PW = DF \times V \qquad \text{eqn. 6}$$

where:

PW = present worth

DF = discount factor = $\frac{1}{(1+r)^n}$

r = prevailing bank interest rate

n = no. of years

V = worth of money in the future

Example: Find the present worth of P1,000 to be received 2 years from now at the prevailing bank rate of 21 per cent.

Solution:

$$PW = \frac{1}{(1+0.21)^2} \text{ x P1,000}$$

$$= 0.683 \text{ x P1,000} = P683$$

- **Benefit-cost ratio (BCR)** is the ratio of present worth of benefit stream to present worth of cost stream, and is given by the equation below:

$$BCR = \frac{\sum_{i=0}^{n} \frac{B_i}{(1+r)^i}}{\sum_{i=0}^{n} \frac{C_i}{(1+r)^i}} = \frac{PWB}{PWC} \qquad \text{eqn. 7}$$

where:

Bi = benefits in period, i where i runs from zero to n

Ci = costs in period i, where i runs from zero to n

PWB = present-worth benefits

PWC = present-worth costs

The investment is said to be profitable when the BCR is one or greater than one. Depreciation and IOI are not included in the costs to prevent double accounting. Depreciation is accounted for by the inclusion of the investment cost while IOI is accounted for by the discount factor.

- **Net present value** is computed by finding the difference between the present worth of benefit stream minus the present worth of cost stream. It is simply the present worth of the cash flow stream, since it is a discounted cash flow measure of project worth along with IRR.

$$NPV = PWB - PWC = \sum_{i=0}^{n} \frac{B_i - C_i}{(1+r)^i} \qquad \text{eqn. 8}$$

- **Internal rate of return (IRR)** is that discount rate which just makes the net present value (NVP) of the cash flow equal zero. It is considered to be the most useful measure of project worth. It represents the average earning power of the money used in the project over the project life. It is also sometimes called yield of the investment.

  It is the maximum interest that a project can pay for the use of resources if the project is to recover its investment and operating cost and still break even. At this point, the BCR is equal to one. This is usually found by trial and error, by interpolation and using following equations:

$$IRR = \left[LIR + (HIR - LIR) \times \frac{NPV_{LIR}}{abs\ /NPV_{HIR} - NPV_{LIR}\ /} \right] \qquad \text{eqn. 9}$$

$$NPV = \text{net present value} \sum_{i=0}^{n} \frac{B_i - C_i}{(1+r)^i} = PWB - PWC$$

where:

LIR	=	lower interest rate
HIR	=	higher interest rate

4 Procedures in Conducting Area Assessment for CHS of AMTs

4.1 Rapid rural appraisal (RRA)

A systematic procedure of interdisciplinary activities for generating community information and analyses.

Other Terms for RRA (Cardenas, 2000)

- Participatory rapid and systematic appraisal (PRSA)
- Rapid community appraisal (RCA)
- Participatory rapid rural appraisal (PRRA)
- Participatory rapid community appraisal (PARCA)

Why is RRA needed?

Rapid, reliable and cost-effective site assessment that involves stakeholder participation, community knowledge using the bottom-up planning approach.

Tools and methods

- personally talking to local people
- directly observing the local conditions
- studying existing conditions prior to project implementation

Variations in RRA application

- type of topic, questions or issues
- purpose or context for which the information is needed
- conditions in the particular area

Aspects on type of topic, questions or issues

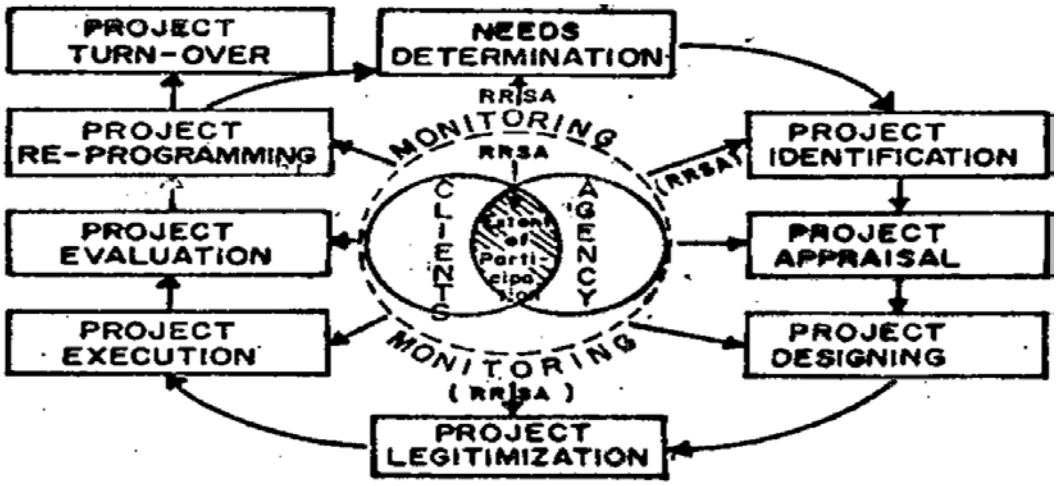
- scope and specificity
- degree and precision needed
- type of subject matter

4.2 RRA applications

- *Exploratory and baseline appraisals*: usually employed in the beginning of a development activity to aid in understanding project implementation

- *Planning appraisals*: used to plan a whole project or some aspect of a project, gain consensus, stimulate accountability and initiate implementing plans of action among local people
- *Feasibility appraisals*: topical appraisal that can be used to detect flaws in technical design and suggest better alternatives for the project
- *Monitoring appraisals*: used in performance review and detecting problems during the project implementation
- *Evaluation appraisals*: aid project implementers in making project changes and in concluding projects

Figure 4.1 Participative project cycle



Formulation of guide questions

Exploratory appraisal should cover the following aspects:

- biophysical aspect
- sociocultural and political aspect
- economic aspect

Fieldwork

- Respondents should be well represented and informed of the activity (sampling method can be applied)
- Key informants should be carefully identified
- Use semi-structured interview (SSI) questionnaire
- Suggested techniques for gathering biophysical information are:
  - participatory modelling
  - participatory transects and diagramming
  - village mapping, etc.

Other forms of participatory data gathering and analysis

- seasonal calendar
- farm diagram
- village map
- product flows

Information checklist

a. *Socioeconomic setting*	b. *Cultural setting*	c. *Biophysical environment*
▪ Demographic information ▪ Income sources (off-farm, on-farm) ▪ Labour availability and distribution ▪ Transport facilities ▪ Market and credit ▪ Channels of market information ▪ Cooperatives and other organizations ▪ Landholdings and inheritance pattern ▪ Land tenure status ▪ Social services	▪ Migration and ethnic groups ▪ Ethnicity and preferences ▪ Leadership patterns ▪ Social structure ▪ Customs and traditions ▪ Organizations in the community, their roles and impacts ▪ Social network ▪ Rights and obligations with regards to sex, age and groups ▪ Prevailing attitudes and beliefs ▪ Indigenous practices related to the use of natural resources ▪ Peace and order situation ▪ History of the area	▪ Land use pattern* and soil fertility* ▪ Rainfall pattern ▪ Availability of water supply ▪ Typhoon occurrence ▪ Drought periods ▪ Land size ▪ Cropping pattern/ farming system ▪ Availability of seeds, seedlings and animal stock ▪ Dominant pests and diseases ▪ Topography, elevation and temperature range* **Can be observed and need not be asked from farmers*

4.3 Assessment techniques

a) RRA techniques

Interview/discussion techniques

- semi-structured
- key informant
- focus or interest groups
- individual and house

Other oral linguistic techniques

- eliciting indigenous technical knowledge
- folk taxonomy
- local custom analysis
- eliciting traditional systems of organizations
- historical profile analysis
- oral histories
- sociolinguistic status distinction

Community exploration

- community appraisals
- group trek
- brainstorming
- participatory workshop

Site characteristic techniques

- agro-ecosystems zoning
- rapid site description

Transect techniques

- transect analysis
- cross section
- mapping/drawing

Ranking, rating and sorting

- item/class ranking
- contrast sets, etc.

Map techniques

- sketch mapping
- thematic maps
- overlay analysis
- mapping of aerial photos
- historical pattern mapping

Diagrams and other graphics

- categorical (circle, pie and Venn diagrams)
- resource diagrams
- seasonal diagrams
- patterns analysis
- decision and logic trees

Significant time analysis

- seasonal events calendars
- timelines
- flow charts

b) RRA principles

- Accuracy and appropriate precision
- Avoiding assumptions and haste
- Conscious judgement
- Exploration and flexibility
- Indigenous knowledge
- Interdisciplinary
- Iteration
- Progressive learning
- Triangulation

- Organize the RRA team
- Introduce the team, explain the purpose, keep a low profile, be polite, thank the participants for attending the discussion after the interview
- Assign roles to RRA team (e.g. topic leaders of topic, group “facilitator” who guides interview or discussion, an arbiter who courteously pacifies potential arguments, etc.)
- Summarize the day’s activity, discuss and identify findings, determine data gaps and plan for the next activities.

5 Post-training Evaluation

5.1 Identify the following:

_____ 1. The application of animal and machine power to multiply a person's ability to perform production operations.

_____ 2. Mechanization model that motivates an increase in the level of mechanization in order to cultivate large agricultural lands with limited available manpower.

_____ 3. Examples of machines that reduce yield losses.

_____ 4. The most common way of representing the level of agricultural mechanization of a country.

_____ 5. A farming system comprising the development and organization or grouping of parcels of lands to effect the efficient application and utilization of powered machines. This includes the necessary physical and institutional infrastructures.

_____ 6. The expenses incurred regardless of whether the machine is operated or not.

_____ 7. The reduction in the value of the machine as a result of use (wear and tear) and obsolescence (availability of newer and better model).

_____ 8. Considered to be the most useful measure of project worth, representing the average earning power of the money used in the project over the project life.

_____ 9. A systematic procedure of interdisciplinary activities for generating community information and analyses.

_____ 10. Usually employed at the beginning of a development activity to aid in understanding project implementation

5.2 Self-assessment test

a) Enumerate the needed information

- 1-2 Models of mechanization
- 3-5 Potentials of mechanization
- 6-7 Purpose of the establishment of custom hiring services
- 8-12 Major key players in the implementation of custom hiring services
- 13-14 Beneficiaries of custom hiring services
- 15-17 Benefits of land consolidation (contiguous farming)
- 18-20 Three major aspects to be considered in the establishment of custom hiring services

b) True or false: Write “T” if the statement is true and “F” if the statement is false.

_____ 1. Highland area to farmer ratio mechanization model motivates an increase in the level of mechanization in order to increase yields and cropping intensities to meet the growing demands for food and agricultural raw materials.

_____ 2. A tractor increases labour productivity.

_____ 3. Intermediate level of mechanization involves operations performed solely through the use of a mechanical power source operated by a person.

_____ 4. Farmers’ preferred agricultural machines should be considered in establishing the custom hiring services.

_____ 5. Land consolidation encourages synchronization of farming to make better use of resources.

_____ 6. Large area and large farm plots are a prerequisite for the implementation of custom hiring services of agricultural mechanization technologies.

_____ 7. The availability of custom hiring services for agricultural mechanization technologies in the area will automatically displace human labour.

_____ 8. The technical aspects of custom hiring services of agricultural mechanization technologies include the perception of the farmer beneficiaries.

_____ 9. Livelihood generation can be realized when implementing custom hiring services of agricultural mechanization technologies.

_____ 10. In custom hiring services of agricultural mechanization technologies, the economic aspect of using the machines is not important.

6 Regional Experience from Selected Countries

6.1 Bangladesh

a) Overview

Table 6.1 Snapshot of Bangladesh

Area of Bangladesh	147,570 sq, km
Total population	144.05 million
GDP	USD 118.42 billion
GDP growth rate	6.03%
Per capita income	USD1044
Manufacturing sector contribution to GDP	18%
Manufacturing sector growth rate	5.73%
Small and cottage industries	6.3%
Medium and large industries	5.5%
Agriculture contribution to GDP	18.70%
Agriculture growth rate	2.17%
No. of farm HHs	15.18 million
No. of non-farm HHs	13.51 million
Cultivated area	8.52 million ha
Cultivated area per HH	0.51 ha
Cropping intensity	190%
Irrigated area	62.96%

Source: *Statistical Year Book of Bangladesh (BBS)*, 2013.

Table 6.2 Agricultural landholdings in different farming segments

Segment of landholding	1983-84	1966	2008
Small farm (0-1 ha)	70.34	79.87	84.27
Medium farm (3 ha and above)	24.72	17.61	14.19
Large farm (3 ha and above)	4.49	2.52	1.52
Total	**100.00**	**100.00**	**100.00**

Source: *Statistical Pocket Book of Bangladesh*, 2010

Table 6.3 Agricultural machinery statistics in Bangladesh

Sl. No.	Farm machinery	Number of units
1	Power tiller	About 700 000
2	Tractor	> 60 000
3	High-speed rotary tiller	> 4 000
4	Weeder	> 250 000
5	Seeder Transplanter	-1 000 -150
6	Sprayer	1 250 000
7	Combine harvester	130
8	Reaper	500
9	Open drum thresher	> 280 000
10	Closed drum thresher	> 50 000
11	Winnower	> 3 000
12	USG Applicator	> 16 000
13	Hand maize sheller	12 000
14	Power maize sheller	30 000

Table 6.4 Agricultural machinery adoption status in Bangladesh

✓ Land preparation	**:**	**> 90% mechanical power**
✓ Seeding ✓ Planting ✓ Transplanting ✓ Fertilizer application ✓ Insecticide application	:	Started by machine (Showing encouraging)
✓ Irrigation	:	> 95% by power operated STW/DTW/LLP pump
✓ Harvesting ✓ Reaper and combine harvester	:	Mostly manually > 90-95% > 10-5%
✓ Threshing	:	Rice and wheat >75%
✓ Shelling ✓ Cleaning ✓ Dryer ✓ Storage	:	Maize >95% by sheller Started by machine (encouraging results)

Table 6.5 Agricultural machinery manufacturing status in Bangladesh

Manufacturing units	Number
Foundries	70
Agri-machinery manufacturing workshops and industries	800
Spare parts manufacturing workshops	1 500
Repair and maintenance workshops	20 000
Mechanics	500 000
Village artisans	100 000

b) Custom hiring

Custom hiring in Bangladesh started in the early 1970s. Power tillers (PT/2WT) and tractors (4WT) were the first machines to be offered. Currently, custom hiring is available for a wide range of machines/operations. In 2013, the Ministry of Agriculture published the National Agricultural Policy; however, there is no custom hiring policy in Bangladesh.

- 2WT and 4WT

  Power tiller:
  - Power tiller: 700,000 units
  - Annual import: 41,000 units, worth BDT 4,100 million (USD 50.0 million)
  - Tractor: 60,000 units
  - Annual import: 6,200 units, worth BDT 6,570 million (USD 80.0 million)

  Tilling cost (PT/2WT & 4WT):
  - Land preparation hiring charge ranges from
    - BDT 3,000 to 3,500 per hectare for one pass
    - BDT 6,000 to 7,500 per hectare for 3-4 pass (complete)

  (USD 1 = BDT 78)

- Irrigation equipment: shallow tube well (STW), low lift pump (LLP), deep tube well (DTW)
  - Present STW population: 1,498,386 units
    LLP: 177,216 units
  - Annual production: 560,000 units, worth USD 16.6 million
  - Potential demand: 850,000 units annually
  - Unmet market size: USD 5.6 million annually

  Irrigation water charge:
  Boro season: BDT 25,000 to 32,000 per ha
  Aman and Rabi crops: BDT 3,000 to 3,500 per ha or BDT 70-100 per hour in case of 2 cusec pump
  Wheat, maize and potato crops: BDT 7,500 to 8,000 per ha

- PT-operated seeders (PTOS), high speed rotary tillers (HSRT)
  - Service providers opined that renting out PTOS/HSRT is a highly profitable business
  - Per unit coverage for land preparation and seed sowing by PTOS/HSRT ranges between 7 and 65 ha (average 36 ha) per year
  - Custom hiring charge for PTOS/HSRT ranges between BDT 4,500 and 5,600 per ha
  - Average gross annual income by a service provider is about BDT 130,500

- Combine harvester reaper
  Total number of combine harvesters 130

  Harvesting charge of rice and wheat range:
  - Rice: BDT 11,500-12,000 per hectare
  - Wheat: BDT 13,500-14,000 per hectare

  Total number of reapers: 500

  Manual method average harvesting, threshing and winnowing costs BDT 16,000 per hectare and it is 35 per cent higher than average cost of harvesting by combine harvester.

  Operating cost of combine harvester for rice harvesting in Bangladesh:
  Effective field capacity
  - Effective field capacity: 1 acre/hr
  - Fuel consumption: 9 litres/hr or 9 litres/acre
  - Fuel Price= 9 × 44.00 = BDT 396.00/acre
  - Operator + Lubricant + others = BDT 250.00/acre (maximum)
  - Harvesting charge = BDT 5,000.00/acre
  - Profit = BDT 4,620.00/acre
  - Profit per day (10 hrs) = BDT 46,200.00
  - Profit per month (30 days) = BDT 1,386,000.00

  1 USD= 78 BDT

- Threshing
  Population of open drum thresher (ODT): 280,000 units
  Closed drum thresher (CDT): 50,000 units
  Annual production of open and closed drum thresher: 20,000 and 80,000
  Annual market size: BDT 3,240 million (USD 39.5 million)
  Threshing paddy and wheat
  Custom hiring charge: BDT 100-140 per ton

- Power maize sheller
  Present population of maize sheller: 30,000 units
  Annual production of maize sheller: 6,500 units
  Annual market size: USD 1.3 million
  Shelling maize
  Custom hiring charge: BDT 30-50 per ton

c) Custom hiring machinery used in Bangladesh
Tractor, rice transplanter, irrigation pumps, power tiller, USG applicator, rice wheat teaser, maize sheller, combine harvester, reaper binder, reaper

Table 6.6 A summary table of charges

S/N	Name of machinery	Use of crops	Charge (BDT/ha)	Charge (USD/ha)
1	4-wheel tractor	Rice (2 pass)	6 670	86
		Wheat (2 pass)	6 670	86
		Potato (4 pass)	13 340	171
		Maize (2 pass)	6 670	86
		Mustard (2 pass)	6 670	86
2	2-wheel tractor	Rice (3 pass)	7 780	100
		Wheat (3 pass)	7 780	100
		Potato (6 pass)	15 560	200
		Maize (3 pass)	7 780	100
		Mustard (3 pass)	7 780	100
3	Irrigation pump	Rice (full-time)	33 590	430
		Wheat (3 times)	8 890	114
		Potato (3 times)	8 890	114
		Maize (3 times)	8 890	114
4	Rice transplanter		7 410	95
5	Rice thresher		3 950	50
6	Wheat thresher		4 940	64
7	Maize sheller		6 000	77
8	Combine harvester	Rice	12 350	158
		Wheat	14 820	190
9	Transportation up to 5 km (round trip)		1,000	13
10	Transportation for 5-20 km (round trip)		1 500	20

USD 1 = BDT 78

6.2 Cambodia

a) Overview

Table 6.7 Agricultural machinery statistics in Cambodia

Year	Harvester	Thresher	Rice milling	Tractor	Power tiller	Water pump
2004	-	6 220	36 531	3 857	20 279	106 569
2005	-	7 338	38 606	4 166	26 504	120 968
2006	325	7 795	38 618	4 247	29 706	127 610
2007	395	8 036	38 680	4 475	34 639	131 702
2008	430	8 237	39 429	4 611	38 912	136 061
2009	836	13 798	47 620	5 495	53 220	164 974
2010	947	14 390	48 217	6 200	66 548	166 633
2011	1 548	15 210	48 753	6 786	77 421	183 502
2012	4 820	16 146	54 328	8 961	128 806	231 942
2013	4 580	17 542	55 270	9 467	151 701	255 954

Table 6.8 Agricultural mechanization ratio in terms of mechanized area by major farm operations

Total of land preparation in 2013 was 3,852,494 ha in which 1,037,307 ha was performed by draft animals and 2,815,187 ha by agricultural machinery

Items	Manual	Animal Power	Agri. Machinery
Land preparation	0	27	73
Broadcasting and transplanting	99.9	0	0.01
Weeding	90	0	10
Fertilizing	100	0	0
Spraying	70	0	30
Harvesting	30	0	70
Threshing	1	1	98
Transportation	0	40	60
Drying	95	0	5
Milling	0	0	100
Average	48.6	6.8	44.6

b) Custom hiring

Custom hiring of farm machinery in Cambodia is different across regions. Most farmers prefer to hire a tractor for land preparation, such as land levelling, ploughing, harrowing and rotavating, and a combine harvester for harvesting. Normally, the custom hiring service can be provided directly to a farmer from the individual service provider or through a broker who deals with requests made by farmers.

Figure 6.1 Custom hiring process in Cambodia

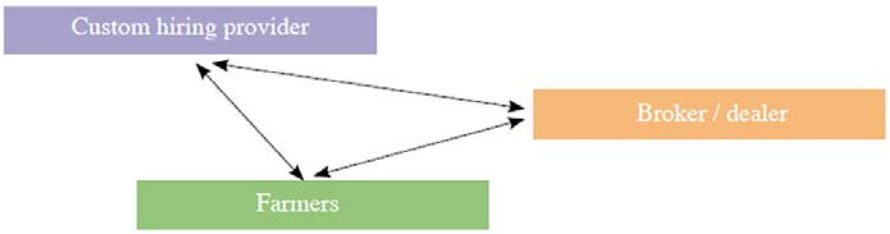


Table 6.9 Farm machinery for paddy production

Operations	Agricultural machinery used
Land Leveling	- **For tractor:** USD 20-25/hr (front shield equipped with tractor) - **For power tiller**: USD 15-20/hr (front shield equipped with power tiller)
Ploughing	- **For tractor:** USD 30-70/hr (depends on distance and field condition) - **For power tiller**: USD 5-45 (depends on distance and field condition)
Harrowing	- **For tractor:** USD 20-40 (depends on distance and field condition) - **For power tiller**: USD 15-20 (depends on distance and field condition)
Rotavating	- **For tractor:** USD 50-70 (depends on distance and field condition)
Harvesting	USD 70-90/ha (with a combine harvester the cost is dependent on distance and field condition)
Threshing	8-10% of total paddy after threshing
Transportation	075-1.25/100 kg (1 sack) It depends on distance and field condition
Drying	USD 20-25/ton of paddy (depends on paddy varieties and moisture content)

* The price varies from one region to another.

Table 6.10 Farm machinery for maize, soybean, cassava production

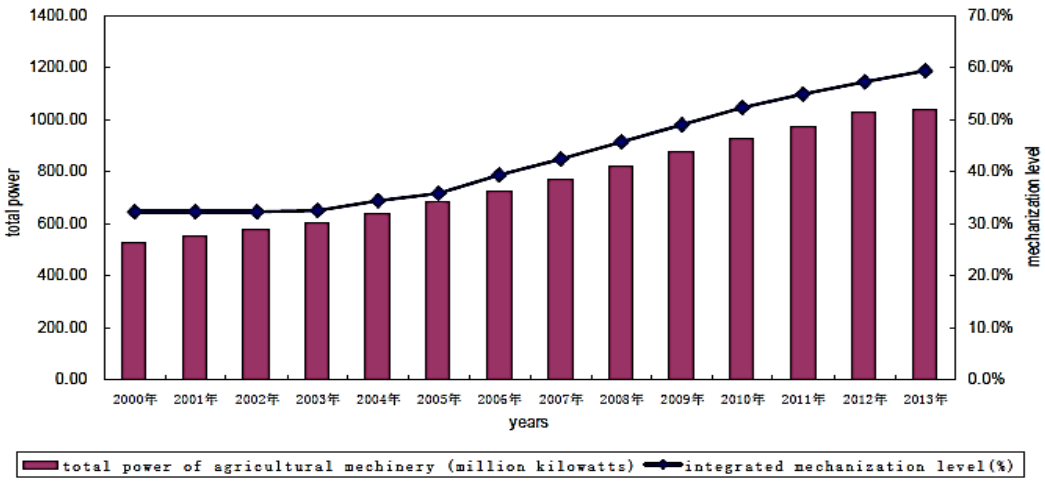
Operations	Agricultural machinery used
Land Levelling	-**For tractor:** USD 35-40/ha (depends on distance and field condition) -**For power tiller**: USD 15-20/ha (depends on distance and field condition)
Ploughing	-**For tractor:** USD 18-20/ha (depends on distance and field condition) -**For power tiller**: USD 12-15/ha

*The price varies from one region to another.

6.3 China

a) Agricultural mechanization level in China

Figure 6.2 China's agricultural mechanization, 2000-2013



b) Custom hiring

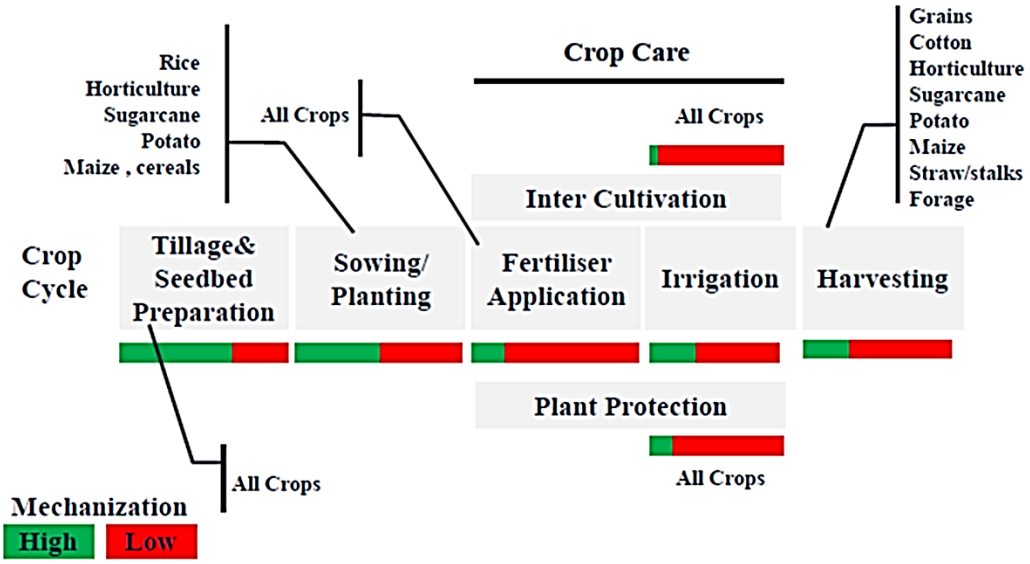
Custom hiring began in 1979. Before 1979, China's rural farmland and farm machinery were collectively owned and custom hiring was not possible. After 1979, China began to reform the household contract responsibility system. This reform laid the foundation for the custom hiring of farm machinery in China, and custom hiring organizations and households began to flourish.

Nowadays, many Chinese rural households purchase farm machines not only to care for their own fields, but also for custom hiring. Around 42 million are farm machine owners, 15.8 per cent of the total rural households; the total operating income of farm machinery owning households has reached RMB 430 billion. Households that make over 60 per cent of their total income from custom hiring services are called machinery service providing households. In 2013, the number of such households reached 5.2 million, 12.3 per cent of the total number of farm machinery owning households.

6.4 India

a) Agrimechanization: status and needs

Figure 6.3 Status and needs of mechanization in India



Harvesting, crop care and seeding are top priorities for the farmer.

- Level of farm mechanization in India: overall about 45 per cent

Table 6.11 Mechanization rate by operation

Operation	Percentage
Soil working and seed bed preparation	40
Seeding and planting	29
Plant protection	34
Irrigation	37
Harvesting and threshing	60-70 per cent for wheat and rice and <5 per cent for others

- Status of farm mechanization industry

Table 6.12 Number of equipment manufacturers

Equipment manufacturers	No. of units
Agricultural tractors	22
Power tillers	5
Irrigation pumps	600
Plant protection equipment	300
Combine Harvester	48
Reapers	60
Threshers	6 000
Seed Drills and planters	2 500
Diesel oil engines	200
Plough, cultivators, harrows	5 000
Chaff cutter	50

b) Custom hiring of farm machines

- Early decades of nineteenth century: 30-inch (diameter) steam thresher
- Mid-1960: organized custom hiring
  Agro-Industries Corporation (AIC) established
- 1970s to 1990s: land development and tillage
- 1971: GOI scheme to set up Agro-Services Centres
- 1990s: Limited under NATP and NAIP
- 2005: All India Coordinated Research Projects (AICRP) (FIM) – 24 centres
- 2010: National Initiative on Climate Resilient Agriculture (NICRA); 100 Agriculture Science Centres (KVKs)
  - in drought/flood/hill area and difficult situations
  - centres managed by farmers through village climate risk management committees

c) Farm machinery banks for custom hiring

- To promote mechanization in districts with low farm power availability
- To facilitate hiring services of various agricultural machinery/implements applied for different operations
- To expand mechanized activities during cropping seasons in large areas especially in small and marginal holdings
- To introduce improved/newly developed agricultural implements and machines to crop production

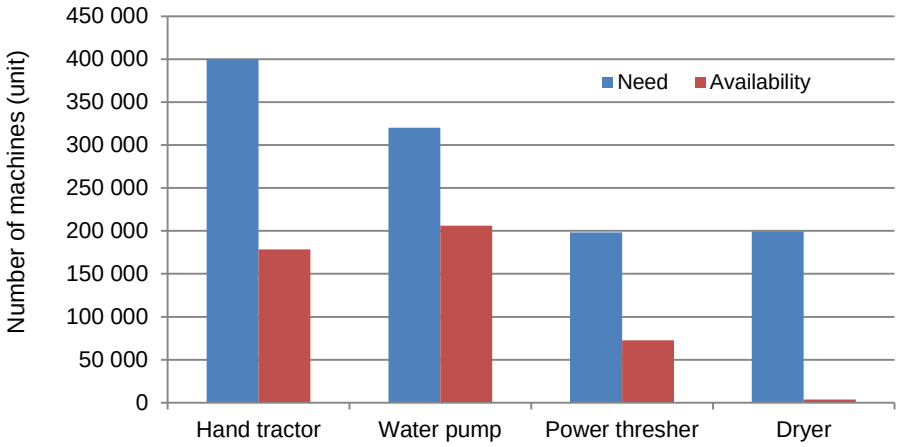
6.5 Indonesia

a) Custom hiring for rental services of agricultural machineries (CHRSAM)

- In 2008, MOA issued a decree to define guidelines for custom hiring. The decree includes the scope to optimize agricultural machinery utilization, both for farmers' groups and service providers.
- Guideline for development of CHRSAM →MOA
  Decree 25/Permentan/PL.130/5/2008

b) Need and availability of agricultural machinery in Indonesia

Figure 6.4 Needs and availability of agricultural machinery



Today, Indonesia has more than 12,000 institutions that support rice production through custom hiring. Known as Institution for Rental Services of Agricultural Machineries (IRSAM), they can be operated by farmers' groups or the private sector.

Table 6.13 Number of IRSAMs for rental services of agricultural machinery in Indonesia, 2006-2012

Year	CHRSAM class			Total
	Beginner	Improved	Professional	
2006	7 390	141	39	7 570
2007	7 543	409	65	8 017
2008	8 571	851	100	9 522
2009	8 145	1 783	318	11 103
2010	8 887	2 250	219	11 356
2011	8 801	2 693	453	11 947
2012	9 485	2 136	423	12 044

Table 6.14 Cost of land preparation and coverage area of hand tractor

CHRSAM	
Beginner	
Cost of land preparation (Rp per ha)	875 000 – 1 200 000
Coverage area (ha per machine)	8-15
Improved	
Cost of land preparation (Rp per ha)	600 000 – 800 000
Coverage area (ha per machine)	9-15
Professional	
Cost of land preparation (Rp per ha)	650 000-800 000
Coverage area (ha per machine)	9-12

6.6 Iran

a) Status of custom hiring

Approximately 5 per cent of farmers own tractors and agricultural equipment; they usually have a farming area of 50 ha or more. These farmers have both capacity and willingness to buy the machinery. However, most farmers own an average of 2 ha and usually hire mechanization services from other farmers. Rural cooperatives, agricultural products cooperatives, agricultural technical advisory units or mechanization service units provide machinery services to farmers. The most popular machines for custom hiring are tractors and combine harvesters. Usually operators are rented along with machines.

Historically, Iranian farms have farmed on a small scale because of inheritance customs. In 2011, the parliament passed a law to prevent the division farmlands between different heirs.

b) Beneficiary Systems of Agricultural Machinery (BSAM)

Beneficiary Systems of Agricultural Machinery (BSAM) is responsible for the establishment of the mechanization unities network. A group of experts constitute the network and it is equipped by a complete set of machinery. It provides different agricultural operations (land preparation, planting and harvesting).

Table 6.15 Units that operate under the BSAM

	Agricultural mechanization servicing unities network	Number	Per cent in network	Area covered (ha)	Area covered per cent in the network
1	Mechanization servicing unities	1 381	50.27	1 907 977	33.25
2	Advisory agricultural technical and engineering unities	521	18.97	1 026 237	17.89
3	Agricultural products cooperative	635	23.12	2 088 568	36.4
4	Rural cooperative	210	7.64	714 987	12.46
	Sum	2 747	100	5 737 769	100

The aim is to cover about 7.5 million ha of cultivated farms using this BSAM mechanization method.

c) Occupational machine owners

Another operating system that provides services is through occupational machine owners (along with operators), especially for tractors and combine harvesters.

Nowadays, there are 107,000 tractor occupational drivers and 14,532 harvester occupational drivers. Tractor owners usually have some mounted or draft equipment, and for other purposes they hire them from another owner or sometimes from equipment holders. Combine harvesters travel from south to the north harvesting wheat, barley and rice across regions.

Current subsidy scheme: To buy new machines, the allocated subsidy is 20 per cent of the total price; the loan is 70 per cent of the total price of machines; and only 10 per cent of the price is to be paid by the suppliants.

According to the new mechanization plan, the government is going to further regulate this service in order to facilitate the creation of agricultural bank loans to replace the old machines.

6.7 Lao People's Democratic Republic (PDR)

a) Overview

- Approximately 80 per cent of the Lao population lives in rural areas
- Per capita gross domestic income is about USD1,646 annually (2013)
- In 2008, economic growth was 7.0 per cent
- GDP
  - agriculture: 44.3 per cent
  - industry: 30 per cent
  - manufacturing and services: 25.7 per cent

b) Custom hiring

- Tractors:
  In general, the first plough operation is done using a tractor, rotary mulcher and heavy power tiller, at a cost of about USD 25/ha. However, the majority of small farmers are using small hand tractors because they are affordable.

- Planter/transplanting machines:
  Custom services for rice transplanting are also used by small farmers, one service package including seedling and transplantation cost about USD 233/ha.

- Harvesters:
  The cost of harvesting operations using combined harvester is about USD 38/ha. Small mowing machines are used by several small farmers, for about USD 12/ha, but another step is needed for threshing. This is usually charged in-kind, not cash; for instance, 1 bag will be withdrawn from 20 bags as a fee for threshing.

- Flat bed dryers for rice and corn:
  Cost of drying operation
  - Rice: USD 6/ton
  - Corn: USD 4/ton

- Rice mill:
  The cost of rice milling is about USD 38/ton; or almost free of charge, if the service provider keeps the rice bran.

6.8 Malaysia

a) Mechanization in rice production

- Rice production is almost 100 per cent mechanized
- Large tractor of 80 hp is used for motivation /land preparation
- Large combine harvester of more than 100 hp is used for harvesting
- Spraying, fertilizing, seeding mainly by power blower
- Transplanting on smaller scale by riding transplanter
- Large centrifugal pump at main pump house and smaller motorized pump at field

Table 6.16 Percentage of machinery utilization in Malaysia rice production

Operation	Machinery	% Machine Utilization
Land preparation	80 hp tractor w/rotovator	98
Seed broadcasting	Power blowout	85
Transplanting	Riding transplanter	5
P&D spraying	Power sprayer	90
Fertilizer application	Power blower	85
Harvesting	Large combine harvester	97
Bulk transportation	1-ton truck	97

Source: Mechanization Technology Status, Plan for Farm Mechanization and Automation, MoA Inc, 2010

b) Custom hiring in rice production

- Tractors, combine harvesters and trucks: 100 per cent hired from contractors
- Seeding, crop care, fertilizing operations: 50 per cent custom hired
- Machinery service provider: <10 per cent govt. agency, >90 per cent private contractors
- Four-wheel tractor: govt. provides 250 units, private contractor 2,950 units
- Combine harvester: govt. provides 92 units, private contractors 1,116 units

6.9 Mongolia

a) Overview

- Agricultural sector produces 21.7 per cent of total GDP
- Agriculture comprises 80 per cent livestock and 20 per cent crop
- 40 per cent of total working force is working in agricultural sector
- Main crops are wheat, potatoes and vegetables

b) Custom hiring

- The government has set aside MNT 7.7 billion to facilitate the establishment of custom hiring centres during 2009-12, as part of its efforts to set up the centres every *aimak* (province) in a phased manner.
- Custom hiring centres rent farm machinery to farmers.
- Crop Supporting Fund (CSF):
- Ministry of Agriculture encourages big farmers or groups of farmers, to jointly purchase high cost machinery and run custom hiring centres. CSF rents

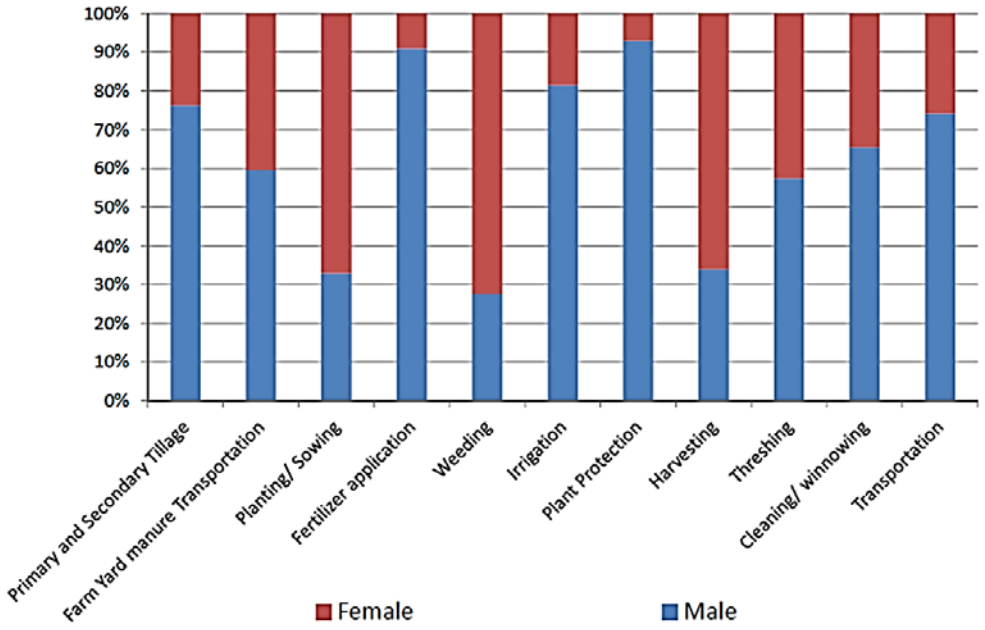
machinery with 20-30 per cent advance payment and is paid the remainder within 3-5 years.

6.10 Nepal

a) Overview

- Dominated by subsistence and smallholder agriculture. Average land size < 0.65 ha.
- Agriculture contributed 34 per cent GDP and employment to about 60 per cent of population
- Young people moving away from agriculture
- Ageing of farm labour
- Feminization in agriculture
- Emerging commercialization in agriculture

Figure 6.5 Gender-wise farm labour involvement in agricultural operation in Terai



b) Custom hiring

Custom hiring has a major role in agricultural mechanization for the following reasons:

- Small landholdings
- Low purchasing capacity
- Low technical capability
- Economy in renting in of agricultural machinery

Figure 6.6 Agricultural mechanization and custom hiring

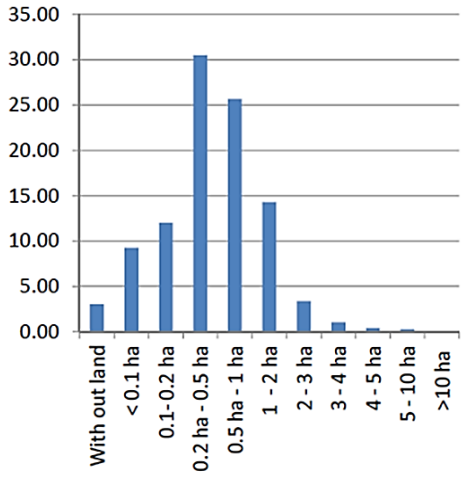


Table 6.17 Custom hiring of equipment

	Used HH	Owned HH	Custom hiring HH	Used/owned
Iron ploughs	1 073 441	838 176	235 265	1.28
Power tillers	75 671	9 123	66 548	8.29
Tractor	844 700	36 158	808 542	23.36
Thresher	803 154	48 157	754 997	16.68
Pumping set	548 203	136 607	411 596	4.01
Animal-drawn cart	334 978	155 272	179 706	2.16
Sprayer	574 014	248 790	325 224	2.31
Other equipment	290 084	81 684	208 400	3.55

Figure 6.7 Share of HH using custom hired agricultural equipment and self-owned equipment

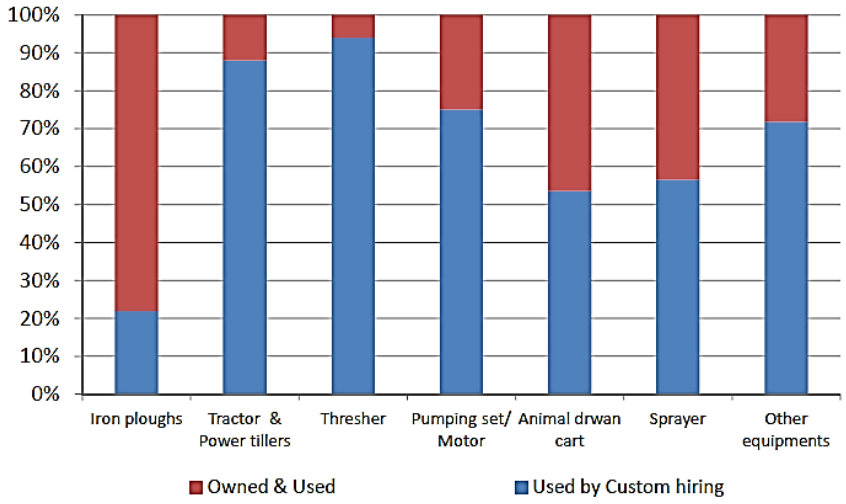


Table 6.18 Custom hire charge of agricultural operation

Custom hiring charge of agricultural operation	Eastern	Central	Western	Mid-Western	Far Western
Tractor with Cultivator (Rs. per hour)	1 200 to 1 500	1 200 to 1 500	1 200	1 000 to 1 200	1 100 to 1 500
Tractor with rotovator (Rs. per hour)	1 600 to 2 000	1 500 to 2 000	2 000	1 400 to 2 000	-
Power Tiller (per hour)	500 to 600	500-600	600	300 to 500	400 to 600
Animal Drawn Plough (Rs. per day)	450 to 1,000	1 000	1 000	700 to 1,000	1 300
Sprayer (per day)	25 to 100	80 to 100	25 to 40	80 to 100	15 to 50
Pump set (Rs. per hour)	300 to 400	250 to 350	300 to 500	250 to 400	250 to 300
Thresher (grain: grain threshed)	1:20 to 1:10	1:12 to 1:8	1:15 to 1:10	1:13 to 1:8	1:9 to 1:07
Combine Harvester (Rs. per hour)	5 000	5 000	4 800 to 5 000	-	4 500

c) Stakeholders' perspectives

Farmers' perspective on custom hiring service provided

- Monopoly of custom hiring service provided
- High rate but cheaper than traditional practice
- Service not available at right time and long waiting times
- Some cases of poor quality of service (grain cracking in threshing)
- Sometimes operation at night
- Difference in rate from one service provider and other
- Straw burning after harvesting led to lack of fodder for livestock farmers

Custom hiring service providers' perspective

- Lack of spare parts and repair and maintenance service
- Low credit availability and high interest rate from bank
- High competition in same location
- Lack of technicians/operators
- Farmers not booking service in advance
- Difficulty in collection of service charge especially during tillage
- No support from government
- Agricultural tractors might be used for non-agricultural use
- Government's inconsistent approach

6.11 Pakistan

a) Overview

Table 6.19 Agricultural snapshot in Pakistan

1. Area under cultivation	22.2 million hectares		
2. Major crops	Wheat, rice, cotton, sugar cane, fruits and vegetables		
3. Share of agriculture GDP Employment	 21% 43.7%		
4. Farm numbers and area (%)	Size (ha)	Farm number and share %	Area
Total farm number: 6.62 million	Up to 2.0 Ha 2.0-5.0 >5.0-10.0 >10.0-20.0 >20.0	(3.6 M) 58% (1.8 M) 27% (0.58 M) 09% (0.26 M) 04% (0.17 M) 1.6%	(3.2 M ha) 14% (5.7 M ha) 26% (3.89 M ha) 18% (3.30 M ha) 16% (4.30 M ha) 21%
5. Subsistence level (5.0 ha)	Up to 5.0 ha landholders are the target farmers for policymakers; there are high numbers of these farmers, who are poor in resources		

Source: Economics Survey & Agriculture Statistics of Pakistan (n.d.)

b) Agricultural mechanization

Table 6.20 Mechanization of crop production operations: present practices and where custom hiring needs improvement

Crop	Land preparation	Sowing	Irrigation	Spraying	Inter-culture	Harvesting	Threshing
Wheat	Semi mech.	Low mech.	Partial mech.	Low mech.	Nil	Semi mech.	Full mech.
Cotton	Semi mech.	Full mech.	Partial mech.	Full mech.	Full mech.	Nil	-
Rice	Full mech.	Nil	Partial mech.	Nil	-	Semi mech.	Partial mech.
Sugar cane	Partial mech.	Partial mech.	Partial mech.	Nil	Semi-mech.	Nil	-
Maize	Full mech.	Semi-mech.	Partial mech.	Nil	Semi-mech.	Low mech.	Full mech.
Potato	Full mech.	Semi-mech.	Partial mech.	Full mech.	Full mech.	Partial mech.	-
Pulses (grams)	Low mech.	Full mech.	Low mech.	Nil	Low Mech.	Nil	Full mech.

c) Custom hiring
- It is a very common practice in Pakistan, mostly by farmers with land size of up to 10 ha (offer and seek)
- Mainly for land preparation/sowing/spraying equipment and wheat threshing by tractor-driven threshers
- New segment: tractor-driven fodder harvesting machines, silage (rapid increase in popularity)

6.12 Sri Lanka

a) Overview
- Land area: 60,600 km^2
- Population: 20.3 million
- Arable area: 30 per cent of the total land area
- Average landholding size: 1.0 ha
- Main crops: paddy, maize, vegetable, fruits, spices, grain legumes, oil crops and root crops
- Plantation crops: tea, coconut, rubber, sugar cane
- Families engaged in agriculture: 1.8 million (49 per cent)
- Agricultural contribution to GDP: 11.1 per cent
- Paddy cultivated area: 34 per cent of the arable land
- Average yield (paddy): 4.5 MT/ha

Table 6.21 Daily wage rate variation from 2003-2012

Operation	Wage rate in 2003 (USD)	Wage rate in 2012 (USD)
Ploughing	2.44	6.59
Sowing	2.30	6.33
Transplanting (F)	1.78	4.66
Spraying	2.54	6.63
Weeding (F)	1.84	-
Harvesting	2.17	6.18

Machinery supply chain: very little machinery, such as water pumps, sprayers, seeders and hand tools, is locally produced. Majority of the machines are imported. However, supply of machinery is not regulated, so inferior quality machinery inflows to the country. Local production is also not supported because of an unfavourable trade policy and small local market.

b) Agricultural mechanization

Table 6.22 Level of mechanization

Paddy cultivation	Highly mechanized
Vegetable cultivation	Low level
Other field crops mechanized	Moderately
Fruit sector	Low level
Plantation crops	Low level
Spices	Very low

c) Custom hiring

History of custom hiring: government-owned tractor hiring centres were established in the late 1960s, with the aim of introducing tractors. All centres were closed down in the late 1970s. As a major breakthrough, tractors (both four wheel and power tillers) have been introduced to the country. Farm machinery research and training programmes have been initiated.

Present status of custom hiring: common hiring machines include combine harvester, combine thresher, four-wheel tractor, sprayer, two-wheel tractor, reaper and water pump.

Table 6.23 Hiring rates

Operation	Hiring rate (USD)
Ploughing	120-140/ha
Reaping	95-115/ha
Threshing	25-30/ha
Combine harvesting	200-225/ha

*Now it has been reduced up to $100/ha

6.13 Thailand

a) Overview

Major crops: rice, maize, sugar cane, soybean, cassava, rubber, horticulture crops, oil palm

Table 6.24 Selected major crop planting and production

Crops	Planting area/million ha	Production/ million tons
Rice	9.5	20.0
Maize	1.2	4.1
Cassava	1.0	18.0

b) Agricultural mechanization

At present, most of the agricultural equipment used in Thailand is locally produced. This includes tractors, power tillers, disc ploughs, disc harrows, water pumps, sprayers, threshing machines, reapers, combine harvesters, cleaning equipment, dryers, rice milling machines and processing equipment.

However, local machines produced by small manufacturers, are not standardized in quality, efficiency and durability. Some agricultural machines are imported from overseas by companies for Thai agricultural production.

c) Custom hiring

At present, there are two ways of utilizing agricultural machinery: as a machine owner and/or machine hiring service. The ratio of machine owner use to machine hiring service depends on size, type and price of machine of equipment.

Most farmers own small and inexpensive machines, such as two-wheel tractors, water pumps and chemical sprayers.

For four-wheel tractors (with rotavator attached for land preparation) and power threshers, only 6.4 and 6 per cent of the total number of machines were owned by farmers.

However, there still are a number of farmers, who have smallholdings or are located in remote rural areas, that cannot afford farm machinery and cannot employ hiring services because their production is too small.

Custom hiring contrcting with large farm machinery in Thailand is a reliable and appropriate service for most farmers. More than 99 per cent of combine harvesters are operated on custom-hire service basis. With this pattern of farm machinery utilization, mechanization for agricultural production will keep expanding and will catch up with the requirements of farmers.

6.14 Philippines

a) Agricultural mechanization

Table 6.25 Level of mechanization by per cent utilization using human, human-animal and human-machine systems in rice production/post-production operations in selected regions in the Philippines

Farm operation	Level of mechanization (% utilization of farmer)			
	Manual operated			
	Camarines Sur (Region V)	Iloilo (Region VI)	Leyte (Region VIII)	Oriental Mindoro (Region IV)
Dike repair	93.75	78.95	88.04	86.32
Planting	100.00	100.00	98.91	98.95
Fertilizer application	100.00	100.00	97.83	100.00
Insecticide application	91.67	74.74	91.30	78.95
Herbicide application	85.42	95.79	35.87*	96.84
Harvesting	100.00	98.95	100.00	89.47
Drying	63.64	53.68	78.26	44.21*

Table 6.26 Machines utilized in rice production/post-production operations in selected regions in the Philippines

Equipment/machine	Camarines Sur (Region V) %	Iloilo (Region VI) %	Leyte (Region VIII) %	Oriental Mindoro (Region IV) %
Hand tractor	91.67	88.54	97.89	86.32
Floating tractor	16.67	11.46	1.05	33.68
Four-wheel tractor	-	1.04	-	4.21
Pump set	21.88	18.75	10.53	38.95
Combine harvester	-	-	-	11.58
Thresher	88.54	87.50	87.37	82.11
Dryer	2.08	8.33	3.16	5.26
Rice mill	55.21	34.38	77.89	18.95

b) Custom hiring

Table 6.27 Percentage of farmers availing custom hiring services in rice production/ post-production operations in selected regions in the Philippines

Operation	Camarines Sur (Region V)		Iloilo (Region VI)		Leyte (Region VIII)		Oriental Mindoro (Region IV)	
	Machine %	Animal %	Machine %	Animal %	Machine %	Animal %	Machine %	Animal %
Seedling preparation	15.63	7.29	1.04	2.08	37.89	38.95	16.84	5.26
Irrigation	5.21		2.08		4.21		4.21	0.00
Ploughing	35.42	13.54	30.21	18.75	20.00	52.63	26.32	7.37
Harrowing	30.21	19.79	32.29	3.13	60.00	17.89	23.16	12.63
Levelling	6.25	46.88	9.38	36.46	2.11	66.32	6.32	26.32
Weeding							22.11	
Harvesting					1.05		41.05	
Threshing/ bagging	53.13		55.21		72.63		41.05	
Hauling farm to road	1.04	2.08	1.04	2.08	3.16		2.11	17.89
Hauling road to storage	4.17	1.04	6.25	1.04	22.11	1.05	7.37	
Drying	2.08		8.33		4.21		1.05	
Transporting	5.21		1.04		24.21		0.00	
Milling	52.08		31.25		73.68		18.95	

Table 6.28 Percentage of farmers availing custom hiring services in corn production/post-production operations in selected regions in the Philippines

Operation	Camarines Sur (Region V)		Iloilo (Region VI)		Leyte (Region VIII)	
	Machine %	Animal %	Machine %	Animal %	Machine %	Animal %
First ploughing	9.38	50.00	3.13	13.54		
First harrowing	7.29	50.00	2.08	7.29	1.05	
Furrowing		66.67		43.75		
Cultivation- hilling up		34.38		6.25		25.26
Cultivation- off barring		4.17		3.13		1.05
Dehusking	3.13					
Hauling - from field		20.83	8.33	19.79		
Hauling – from road	3.13	8.33	11.46	4.17	5.26	
Shelling	73.96		67.71		2.11	
Drying - before shelling	0.00		1.04		1.05	
Drying - after shelling	10.42		4.17		2.11	
Transportation	2.08		50.00	4.17	63.16	
Milling			1.04		75.79	

6.15 Viet Nam

a) Agricultural mechanization

According to 2013 statistical data, the level of agricultural mechanization in Viet Nam, in terms of available mechanical power, is still low with only 1.16 hp/ha of cultivated land. The Mekong River Delta has highest rate with 1.85 hp/ha.

Table 6.29 Level of mechanization in rice production

Agricultural production activities	Mechanization rate (%)
Soil preparation for rice cultivation (mainly used two-wheel tractors of 8-15 hp and four-wheel tractors of 20-50 hp)	90
Transplanting	≤ 1
Active irrigation for rice	94
Rice harvesting (combine harvesters, windrow-reapers and threshers) - in Mekong River Delta (MRD) - in Red River Delta (RRD)	35 65 60
Rice drying in summer-autumn season in MRD	45
Rice milling	95

Source: Stat. data, 2013

Table 6.30 Level of mechanization in sugar cane production

Agricultural production activities	Mechanization rate (%)
Soil preparation for sugar cane cultivation (at flat terrains, about 60% of the total sugar cane growing areas)	80-90
Crop care, weed tilling, fertilizing	10
Transportation	100
Planting, collecting, handling and harvesting	Mostly by hand

Source: Stat. data 2013

b) Custom hiring

Former owners of agricultural machines and equipment (before 1986) were mainly state-owned enterprises, this is now moving to private ownership and households.

Providers of mechanization services include:

- agricultural cooperatives
- private enterprises

Both providers buy agricultural machines to provide services.

The "Land consolidation" policy initially achieved positive results. Average number of plots from 6.8 plots/HH dropped to 4-5 plots/household. System of agro-machinery services through stores, selling agents and logistics is growing very fast. These services are largely operated by private cooperatives, accounting for about 80 per cent of the service providers.

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