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Importance of Farm Machinery Data for Promoting Sustainable Agricultural Mechanization

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Engineering interventions in agriculture sector are required for

Increasing –

- Production & Productivity
- Comfort & Safety
- Return and profitability to the farmers

Reducing -

- Cost of cultivation
- Drudgery
- Environmental footprint

Through

- Enhanced input use efficiency, and
- Timeliness of operations

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FARM MECHANIZATION

Mechanization is a package of technology and farm tools and equipment to

a. **Ensure timely field operations to increase productivity, reduce crop losses and improve quality of agro-produce**

b. **Increase land utilization and input use efficiency**

c. **Increase labour productivity using labour saving and drudgery reducing devices besides, being cost effective and eco-friendly.**

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FARM MECHANIZATION

- **Mechanization indicator is one of the measures of modernization of agriculture of a country**
- **Availability of farm power or energy per unit area (kW/ha) has been considered as one of the parameters for expressing level of mechanization.**

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Key Elements Influencing Agricultural Mechanization

- Agricultural mechanization status
- Farm power sources and availability
- Cropping patterns
- Cropping intensity
- Irrigation intensity
- Production and productivity goals
- Shifting trend in power sources
- Tractor/power tiller annual use and use patterns

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- Direct ownership versus custom hiring
- Farm machinery management data
- Augmenting R&D in tractors & farm machinery
- Area for futuristic research
- Farm machinery manufacturing aspects
- Standardization & quality certification
- Credit and financing of tractors and farm machines
- Training

Farm Machinery Management

The importance of farm machinery management has increased in modern farming operations because of its direct relation to the success of management in combining land, labour and capital for a satisfactory profit. Many problems of machinery management are encountered such as:

i) how many equipment should be owned?;
ii) What size of equipment is required?;
iii) How often should the machinery be traded?;
iv) Should a custom operator be hired or a machine be leased?; and
v) How can the rapidly increasing fuel costs be kept to the minimum?.

Farm Machinery Management

In this scenario the farmer needs to prepare himself to satisfy the increasing needs for machinery management. He must learn how to use the machinery; keep complete records of fieldwork done by various machines and the number of working days available for critical field operations; know how to accurately estimate costs for any machine and how to combine costs of machines to estimate total cost for an entire system; know how to improve equipment reliability; improve field efficiencies with machines to cut costs and complete more work in the available time; develop a long-range plan for his farming operations; keep thinking of ways to improve the efficient ownership and management of agricultural machinery; and review the problems encountered

Need for Regional Database on SAM

- Agricultural mechanization is not uniform across the countries in the Asia-Pacific region
- Appropriate/Sustainable mechanization is a complex and continuous exercise due to contrasting needs of region/country i.e. different ecosystems, crops, farming operations, user groups, farmland holders etc.
- Efforts to promote site-specific sustainable agricultural mechanization require a sound regional database

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- Lack of a uniform database framework hampers effective use of statistics on mechanization
- Need to harmonize definitions and units of measurement
- Serve as a common reference to ensure compatibility of shared information and guide development of a regional database in future
- Provide tool for capacity building

Objectives of Guidelines for Collection of Data

- Provide key indicators pertaining to sustainable agricultural mechanization and link them with SDGs' monitoring and reporting efforts
- Provide classifications of identified indicators and further group them into three categories as per need or urgency (i.e. Core, Preferred and Extended indicators)
- Provide definitions, data samples and update frequency of indicators by comparing commonly referred sources, for serving as a reference for national and regional stakeholders

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Target Group for Guideline

- **Reference guide for:**
  - Staff and practitioners in national offices or research institutes working on statistics related tasks, data collection or processing
  - Other researchers and institutions
  - Policymakers and policy analysts who need data for policy formulation or evaluation
  - Entrepreneurs and enterprises who need to make evidence-based business decisions
  - Development partners including NGOs seeking collaborative opportunities

Terms used in Mechanization

Cropping Intensity i.e. how many crops are grown per year

= Crops grown per unit cultivated area

= Gross cultivated area/net cultivated area

Gross cultivated area = total use of net cultivated area per year

Productivity (Yield) = Total grain production (tonnes)/area cultivated (ha)

1. Land use classification and land holding

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Table 3.1.1a: Land use classification and land holding

Classification	Years						
Geographic area ('000 ha)							
Forest and other wood land ('000 ha)							
Non-agricultural uses ('000 ha)							
Barren & uncultivable land such as water bodies, hills etc. ('000 ha)							
Cultivable land ('000 ha)							
Net area sown ('000 ha)							
Irrigated area ('000 ha)							

Note: This information is required after every 10 years

Table 3.1.1b: Average size of holdings by different size classes (ha)

Major size classes*		Year			
Marginal	< 1 ha				
Small	1 - 2 ha				
Semi-medium	2 - 4 ha				
Medium	4 – 10 ha				
Large	10 ha & above				
All size classes					

*May follow your own country's classification

Note: This information is required after every 10 years

Table 3.1.2: Distribution of land tenure status and distribution of farm holding

	Total holdings with land (Total number of parcels)	Total area (ha)	Percent of agricultural holdings						Average size of operated area per holding (ha)
			Under 0.5 ha		Under 1 ha		Under 2 ha		
			By Number	By Operated Area	Number	Operated Area	Number	Operated Area	
Owned by men									
Owned by women									
Total									

Note: This information is required after every 10 years

2. Cropping systems

Table 3.2.1a: Agro-Ecological Zones (AEZs)

S. No.	Agro-Ecological Zones	Province/State covered
1		
2		
3		
4		
5		
6		

Note: This information is required after every 10 years

Table 3.2.1b. Crop calendar for different major cropping systems showing key activities

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AEZ-1/ Province/State												
Crop A: Maize	LP/SP				HT	LP/SP				HT/LP		
Crop B: Cotton					LP/SP						Picking	
Crop C: Rice Crop D: Wheat	LP/SP		HH/LP		HT	LP/Transplanting				HT/LP		
Crop A: Fallow: Crop C												

AEZ-2/ Province/State												

Note: LP: Land preparation; SP: Sowing/Planting; HT: Harvesting/threshing Multiple crops per year (cropping intensity) can also be exhibited in the calendar with mention of major/minor/cash crops.

Note: This information is required after every 5 years

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Table 3.2.2: Major cropping systems

AEZ/ Province/ State	Cropping pattern				
	Rice-rice	Rice-wheat	Maize-wheat	Sugarcane-sugarcane	Any other
AEZ-1/ Province/ State					
AEZ-2/ Province/ State					
Etc.					
Country level					

Note: This information is required after every 5 years

Table 3.2.3: Cultivation under covered area ('000 ha)

AEZ/ Province/State	Year			
AEZ-1/ Province/State				
AEZ-2/ Province/State				
Etc.				
Total for country				

Note: This information is required after every 5 years

Table 3.2.4: Cropping intensity (Percent)

AEZ/ Province/State	Year			
AEZ-1/ Province/State				
AEZ-2/ Province/State				
Etc.				
Total for country				

Note: This information is required every year

Table 3.2.5: Crop-wise irrigated area (‘000 ha) and percent

Crops	Year			

Note: This information is required every year

Table 3.2.6: Total area under micro-irrigation

Agro-ecological zone/Province/State	Area under micro-irrigation (ha)	Remarks (major use in)
		e.g. Vegetables
		e.g. Horticulture, Vegetables
		e.g. Field crops, Vegetables,…
TOTAL		

Note: This information is required after every 5 years

3. Basic inputs

Table 3.3.1: Basic inputs used in agriculture

Basic inputs	Year			
Seeds as per crop type (‘000 tonnes)				
Fertilizers (N, P, K) as per type (‘000 tonnes)				
Chemicals (Insecticides, pesticides) as per types (‘000 liters)				

Note: 1.This information is required every year
2.Additional rows for different types to be added as per need

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Table 3.3.2a: Province-wise/State-wise net area irrigated ('000 ha)

Province/State	Year			

Note: This information is required every year

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Table 3.3.2b: Net area irrigated ('000 ha) by different sources

Source of irrigation	Year						
Rainfall							
Rivers							
Lakes							
Groundwater wells							
Diversions							
Irrigation canals							
Total							

Note: This information is required every year

Table 3.3.3: Water productivity and nutritional water productivity

Major crops	Field water productivity (kg/m^3) range in Min-Max	Nutritional water productivity	
		Protein unit (g/m^3)	Energy unit (MJ/m^3)

Note: This information is required after every 5 years

4. Mechanized Inputs

Table 3.4.1: Rural population and agricultural workers (millions)

Year	Total population	Rural population	Cultivators	Agricultural labourers	% agricultural labourers

Note: This information is required every year

Table 3.4.2: Draft animal power and their major involvement in agrarian activities

Draught Animal Power	2010		2015	
	Population ('000)	Major uses in agriculture	Population ('000)	Major uses in agriculture
Cattle (Oxen, bulls, cows)				
Horses				
Mules				
Donkeys				
Camel				

Note: This information is required after every 5 years

Table 3.4.3: Province-wise/State-wise and horse power-wise sale of tractors (in '000)

Province/State	Power (kW)					Total
	up to 20	21-30	31-40	41-50	above 51	
Country						

Note: This information is required every year

Table 3.4.4: Province-wise/State-wise and horse power wise sale of power tillers (in '000)

Province/State	Power (kW)		Total
	up to 7.5	Above 7.5	
Country			

Note: This information is required every year

Table 3.4.5: Population of farm power sources ('000)

Year	Agricultural Workers	Draft Animals	Tractors	Power Tillers	Engine operated by			Electric Motor operated	Total
					Diesel	Gasoline	Kerosene		

Note: This information is required every year

Table 3.4.6: Total number of irrigation pump-sets ('000)

Type	Year			
	2000	2005	2010	2015
Water pump				
Submersible pump				
Drip irrigation				
Sprinkler irrigation				

Note: This information is required after every 5 years

Table 3.4.7: Total number of manually operated equipment

Major uses in agriculture	Manually operated equipment	Population (million)		
Land preparation	Soil dragger, Soil fork, Rake, Shovel, etc.			
Seeding/planting	Drum seeder, rotary dibbler, etc.			
Fertilizing	Fertilizer applicator, Broadcaster, etc.			
Irrigation and water lifting	Treadle pump, etc.			
Crop care and maintenance	Axe, Spade, Blade digger, Hand hoes, etc.			
Harvesting	Sickle, lever, etc			
Horticultural operations	Plucker, Peeler, Scissors, etc.			
Others (if any)	---			

Note: This information is required after every 5 years

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Table 3.4.8: Total number of animal operated equipment

Major uses in agriculture	Animal operated equipment (below are examples only)	Population ('000)		
		2005	2010	2015
Land preparation	Cultivators			
	Harrows			
	Puddlers			
	Levelers			

Seeding/planting	Seed drills/seed-cum fertilizer drills			
	Planters			

Fertilizing	Manure distributors			

Irrigation and water lifting	Water lifting devices			

Note: This information is required after every 5 years

Table 3.4.8: Total number of animal operated equipment – contd.

Major uses in agriculture	Animal operated equipment (below are examples only)	Population ('000)		
		2005	2010	2015
Crop care and maintenance	Sprayers			
Harvesting and threshing	Reapers			
	Reaper binders			

Horticultural operations				
Haulage / transportation	Cart			
Seed processing (oil mills etc.)	Oil mills			
	Flour mills			

Crop processing (crushers etc.)	Cleaners			
	Graders			

Others				

Note: This information is required after every 5 years

Table 3.4.9: Total number of tractor operated earth-moving/leveling/ tilling machines ('000)

Type	Year			
	2000	2005	2010	2015
Earth-movers				
Excavators				
Diggers				
Ditchers				
Mould Board plows				
Disc plows				
Cultivators				
Harrows				
Rotary tillers (Rotavators)				
Others				

Note: This information is required after every 5 years

Table 3.4.10: Total number of power tiller operated earth-moving/leveling/ tilling machines ('000)

Type	Year			
	2000	2005	2010	2015
Earth-movers				
Excavators				
Diggers				
Ditchers				
Mould Board plows				
Disc plows				
Cultivators				
Harrows				
Rotary tillers (Rotavators)				
Others				

Note: This information is required after every 5 years

Table 3.4.11: Total number of tractor operated seed drill/ planters/transplanters/broadcasters/power weeders ('000)

Type	Year			
	2000	2005	2010	2015
Seed-cum-fertilizer drills				
Planters				
Transplanter				
Broadcasters				
Power weeders (including tractor operated and self-propelled)				
Sweep cultivator				
Others				

Note: This information is required after every 5 years

Table 3.4.12 Total number of power tiller operated seed drill/ planters/transplanters/broadcasters/power weeders

Type	Year			
	2000	2005	2010	2015
Seed-cum-fertilizer drills				
Planters				
Transplanter				
Broadcasters				
Power weeders (including tractor operated and self-propelled)				
Sweep cultivator				
Others				

Note: This information is required after every 5 years

Table 3.4.13: Total number of sprayers, dusters and horticultural equipment (‘000)

Type	Year				
Sprayers/misters					
Dusters					
Spreader					
Broadcaster					
Foggers					
Others					

Note: This information is required after every 5 years

Table 3.4.14: Total number of sprayers, dusters and horticultural equipment ('000)

Type	Year			
	2000	2005	2010	2015
Humidifiers-dehumidifiers				
Grass shearer				
Chain saw				
Power mower				
Pneumatic secateurs				
Intercultivators				
Earth auger				
Tree pruner				
Hedge trimmer				
Mist blower				
Others				

Note: This information is required after every 5 years

Table 3.4.15: Total number of tractor/power tiller operated and self-propelled harvesting and threshing equipment (‘000)

Type	Year			
	2000	2005	2010	2015
Digger				
Reapers and reaper Binders				
Threshers/multi-crop threshers				
Grain harvesters				
Maize harvesters				
Cotton pickers				
Others				

Note: This information is required after every 5 years

Table 3.4.16: Total number of farm transport/haulage ('000)

Type	Year			
	2000	2005	2010	2015
Tractor drawn trailers				
Trailers coupled with modified prime mover				
Animal-drawn trailers				
Conventional and modified carts				
Others				

Note: This information is required after every 5 years

Table 3.4.17: Total number of drying/milling and other grain processing equipment ('000)

Type	Year			
	2000	2005	2010	2015
Drying equipment				
Milling equipment				
Grading equipment				
Cleaning equipment				
Parboiling unit				
Rice dehuller				
Huller-polisher				
Rubber roll sheller				
Germ separator				

Note: This information is required after every 5 years

Table 3.4.17: Total number of drying/milling and other grain processing equipment ('000) – contd.

Type	Year			
	2000	2005	2010	2015
Rice puffing machine				
Soybean blanching unit				
Soy pressing machine				
Expeller				
Sugarcane crusher				
Cassava chopper				
Peeler				
Fruit grader				
Others				

Note: This information is required after every 5 years

Table 3.4.18: Total storage systems capacity ('000m^3)

Type	Year			
	2000	2005	2010	2015
Bins				
Silos				
Cold storage facility				
Others				

Note: This information is required after every 5 years

Table 3.4.19: Total number of livestock and aquaculture machines in use ('000)

Livestock/aquaculture equipment	Year			
	2000	2005	2010	2015
Dairy equipment				
Poultry equipment				
Meat processing equipment				
Hatchery, Rearing				
Aeration and Feeding				
Intensive aquaculture				
Harvesting equipment				
Packaging, Stocking, Transporting				
Others				

Note: This information is required after every 5 years

Table 3.4.20: Sample reporting of total tractor horsepower

All agricultural tractors (including power tillers) in use	Rated power range (hp or kW) as specified by manufacturer	Mid-range value (hp or kW)	Units in use (numbers)	Power in use (hp or kW)
Small sized tractors	< 20 hp (A = 20)	0.5 A = 0.5 x 20 = 10 hp	Say N	N x 10 = 10 N hp or N x 10 x 0.746 = 7.46 N kW
Medium sized tractors	21 to 50 (B = 50)	0.5 (A + B) = 0.5 (20 + 50) = 35 hp	Say N_1	N_1 x 35
Large sized tractors	51 to 100 (C = 100)	0.5 (50 + 100) = 75 hp	Say N_2	N_2 x 75
Very large sized tractors	> 100	1.5 C = 1.5 x 100 = 150 hp	Say N_3	N_3 x 150

Note: This information is required every year

Table 3.4.21: Power from different sources

Year	Agricultural Workers ('000kW)	Draft Animals ('000kW)	Tractors ('000kW)	Power Tillers ('000kW)	Engines ('000 kW)	Electric Motors ('000 kW)	Total power ('000 kW)	Power availability per hectare (kW/ha) (Total power/ net sown area)

Note: 1 Human= 0.05 kW; Draught animal = 0.38 kW; Tractor = 26.1 kW;
Power tiller = 5.6 kW; Electric motor = 3.7 kW; Diesel Engine = 5.6 kW

You may have your own values as per country's need

Note: This information is required every year

Table 3.4.22: Contribution of different power sources to total power

Year	Total Power ('000hp or kW)	Agricultural Workers (Percent)	Draft Animals (Percent)	Tractors (Percent)	Power Tillers (Percent)	Engines (Percent)	Electric Motors (Percent)

Note: This information is required every year

Table 3.4.23: Mechanization index

Year	E_M (kWh/ha)	E_H (kWh/ha)	E_A (kWh/ha)	E_F (kWh/ha)	E_E (kWh/ha)	E_M (kWh/ha)	MI (%)

Mechanization index (MI) is expressed by the *percentage* of machine (motorized) work E_M to the total farm power availability (e.g. sum of human E_H, animal E_A, fossil fuel E_F, electricity E_E, and machine work E_M) expressed in energy units;

$$MI\ (\%) = \frac{E_M}{E_H + E_A + E_F + E_E + E_M}$$

E_H = Average sum of all human operational works, kWh/ha
E_A = Average sum of all animal operational works, kWh/ha
E_F = Average sum of all fossil fuel consumption in agriculture, kWh/ha
E_E = Average sum of electricity consumption in agriculture, kWh/ha
E_M = Average sum of all mechanical operational works, kWh/ha

Table 3.4.24: Availability of power sources and farm machines per 100 ha arable land

Type	Year			
Tractors				
Power Tillers				
Earth-movers				
Excavators				
Ditchers				
Mould Board plows				
Disc plows				
Cultivators				
Harrows				
Rotary tillers (Rotavators)				
Seed-cum-fertilizer drills				
Planters				
Transplanter				

Note: This information is required after every 1-2 years

Table 3.4.24: Availability of power sources and farm machines per 100 ha arable land – contd.

Type	Year			
Broadcasters				
Sprayers/dusters				
Power weeders (including tractor operated)				
Digger				
Reapers & reaper Binders				
Threshers/Multicrop threshers				
Grain harvesters				
Maize harvesters				
Cotton pickers				
Others				

Note: This information is required after every 1-2 years

5. Production and productivity

Table 3.5.1: Area and production of major crops

Year	Rice		Wheat		Maize		Total pulses	
	Area ('000ha)	Production ('000t)	Area ('000ha)	Production ('000t)	Area ('000ha)	Production ('000t)	Area ('000ha)	Production ('000t)

Note: This information is required every year

Table 3.5.2: Cultivated area, irrigated area and productivity

Year	Net sown area ('000 ha)	Gross sown area ('000 ha)	Net irrigated area ('000 ha)	Gross irrigated area ('000 ha)	Area under food grains ('000 ha)	Production* ('000 tonnes)	Productivity* (tonnes/ha)

* Food grains only

Note: This information is required every year

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6. Agriculture and Environment

Table 3.6.4: Agro-ecological regions and area under broad soil groups

S. No.	Agro-ecological Zones/ Province/State	Area under broad soil groups (ha)
1		
2		
3		
4		
5		

Note: This information is required after every 10 years

Table 3.7.6: Agricultural machinery trade

Machinery category	Import		Export	
	Volume (units)	Value (USD)	Volume (units)	Value (USD)
1. General purpose machines				
Stationery motors/engines				
Farm transport/haulage machines				
2. Water management machines				
Irrigation pump-sets including pumps, engines, motors				
3. Animated power sources				
Tractors				
Power tillers				
4. Field preparation and planting machines				
Total number of earth-moving/leveling machines				
Total number of planters, transplanters, broadcasters				

Note: This information is required after every 5 years

Table 3.7.6: Agricultural machinery trade – contd.

Machinery category	Import		Export	
	Volume (units)	Value (USD)	Volume (units)	Value (USD)
5. Harvesting and threshing machines				
Diggers/ reapers/binders				
Threshers/harvesters/ combines				
6. Postharvest and processing machines				
Drying/ milling equipment				
Other grain processing machines				
7. Livestock machines				
8 Aquaculture machines				
9. Plant protection, crop maintenance, and horticultural equipment				
Sprayers				
Dusters				
Weeders				
10. Others, please specify				

Note: This information is required after every 5 years

Table 3.7.7: Agricultural machinery export subsidy

Machinery category	Export subsidy	
	Value (USD)	Proportion of total amount worth of machinery in the given category
1. General purpose machines		
Stationery motors/engines		
Farm transport/haulage machines		
2. Water management machines		
Irrigation pump-sets including pumps, engines, motors		
3. Animated power sources		
Tractors		
Power tillers		
4. Field preparation and planting machines		
Total number of earth-moving/leveling machines		
Total number of planters, transplanters, broadcasters		

Note: This information is required every year

Table 3.7.7: Agricultural machinery export subsidy- contd.

Machinery category	Export subsidy	
	Value (USD)	Proportion of total amount worth of machinery in the given category
5. Harvesting and threshing machines		
Diggers/ reapers/binders		
Threshers/harvesters/ combines		
6. Postharvest and processing machines		
Drying/ milling equipment		
Other grain processing machines		
7. Livestock machines		
8 Aquaculture machines		
9. Plant protection, crop maintenance, and horticultural equipment		
Sprayers		
Dusters		
Weeders		
10. Others, please specify		

Note: This information is required every year

Table 3.7.8: Average prices of custom hiring of agricultural machinery

Activity in agriculture for custom hiring	Unit	Specifications / Remarks	Price (USD per unit)	
			Max.	Min.
Crop-1				
Activity-1				
Activity-2				

Crop-2				

General services				

Note: This information is required every year

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