AGRICULTURAL MECHANIZATION DEVELOPMENT IN THAILAND
General Background

Contribution for agricultural sector

- **Fishery**: 22.4%
- **Livestock**: 15.6%
- **Forest**: 0.02%
- **Other**: 0.18%
- **Crops**: 61.8%

Rice (49.8%)
- Horticulture crops (21.2%)
- Field crops (21.5%)
- Other crops (7.5%)
General Background

Major crops:

Total agricultural land  20.8 mil. ha.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Planting area</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>9.5 mil. ha.</td>
<td>20 mil. tons</td>
</tr>
<tr>
<td>Maize</td>
<td>1.2 mil. ha.</td>
<td>4.1 mil. tons</td>
</tr>
<tr>
<td>Cassava</td>
<td>1 mil. ha.</td>
<td>18 mil. tons</td>
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</tbody>
</table>
2. Agricultural Machinery Development

Development of agriculture in Thailand can be divided into three stages:

1. Rice monoculture/natural resource-based (Pre-1955),

2. Land-based resource/labor-intensive methods (1955-85) and

Relationship between energy input and crop production in Thailand during 1950-2005

\[ y = 13.462 \ln(x) - 19.904 \]

\[ R^2 = 0.9728 \]
Contribution of different energy inputs in crop production in Thailand during 1950-2005
Success stories in agricultural machinery

In 1964-1965, workshops around the Bangkok area began to modify the design of imported 2-wheeled tractors by trial and error method. Only one workshop succeeded in simplifying the gearbox and other parts of the tractor to suit local paddy field conditions. In 1966, a few firms began producing 2-wheeled tractors. The lower price of these tractors relative to the imported tractors and their suitability to local conditions made them popular, and their adoption spread to all parts of the Central plain.
In 1975, the Agricultural Engineering Division constructed the prototype for an axial flow rice thresher, which received its blueprint from the International Rice Research Institute (IRRI), then released it to a selected firms in Chachoengsao province for commercial production.

Later in 1975, a new blueprint was released to three firms for commercial production, and subsequently it was widely used and developed with very high successfully development.
At present, this machine has still be popular used especially in the North and the North East regions while it was not used in the Central plain region because it was replaced by the using of Thai-made rice combine harvester.
Figure 1: Flow chart of the development of axial flow thresher innovation and adoption (a historical background).

DEVELOPMENT OF

THAI RICE COMBINE HARVESTER

• During the previous Sixth Five – Year National Economic and Social Development Plan(1987-1991), the economic structure rapidly changed from agriculture to industry.

• Labor force from agricultural sector resulting in shortage of labor for some farming operations.
FIRST COMMERCIAL

1983

PROTOTYPE
THAI RICE COMBINE HARVESTER

1985
30 WORKSHOPS & MANUFACTURERS
STEP IN LARGE MANUFACTURERS
THAI RICE COMBINE HARVESTER

- Mass production of rice combine started in 1987 when a pioneer workshop joined with a business group to establish a factory. At the same time rice thresher manufacturers whose productions were affected by the adoption of the combine changed some of their production lines to produce this newly developed machine.
RELIABILITY

Durability
Grain Tank type

(1) Undercarriage
(2) Harvesting head hydraulic cylinder
(3) Hydraulic double pumps
(4) Universal joint for hydraulic double pumps
(5) Engine set
(6) Exhaust muffler
(7) Main engine idle set
(8) Harvesting table unit
(9) Dust blower
(10) Chain conveyor unit
(11) Threshing unit
(12) Grain tank loading auger
(13) Grain tank
(14) Swinging unloading conveyor
(15) Operator’s platform
(16) Hydraulic oil cooler
(17) Front head light
(18) Hydraulic oil tank for main transmission system
(19) Hydraulic oil tank for unloading auger and harvesting head
(20) Air filter
(21) Radiator
(22) Fuel tank
(23) Battery
(24) Reverse rotation gear box
(25) Plastic shelter
(26) Belts guard
COMBINE HARVESTER WITH GRAIN TANK
Kaset Phaitana Combine Harvester

FOR ITS BEST INVENTION IN 1995.

QUALITY RELIABILITY: RESPONSIBILITY

COMBINE HARVESTER

HIGH POWER SERIES

- Powerful Windrow Diesel Engine
- Dual cylinder 3450 cm³, 120 HP, 1800 rpm
- Maximum rated diesel power 125 HP, at 2000 rpm
- Maximum torque 1100 Nm at 1300 rpm
- Maximum output speed 24 km/hr
- Maximum travel speed 18.5 km/hr
- Carburettor
- Maximum horizontal speed 6 km/hr

FULL TRANSMISSION SYSTEM

- Drive gear box, pump and
- Planetary gear box units
- Transmission, 15 3/4 in. wide, belt
- Power transmission

HIGH QUALITY COMPONENTS

- Parts
- Planetary gear box

PLANTILLA GEARBOX UNDER-CARRIAGE

OUTERS AND GUARDs

FOR ALL PADDY CROP CONDITIONS
FIVE MANUFACTURERS

1-2 million Baht

800 - 1000 UNITS/year
1. STEP BY STEP DEVELOPMENT
2. CUSTOM HIRE SERVICE SYSTEM
3. APPROPRIATE FOR THAI PADDY FIELD
At the beginning of the introduction of the combine harvester, rice is combined at relatively high moisture, sometimes as high as 28%, but the average moisture at harvest is about 24%.

Farmer does not dry his own paddy but sell it to the miller or the collector right away. The high moisture rice is immediately transported to the rice mill or the local collector. Most millers and collector at that time had no mechanical dryer, drying the high moisture rice depend mostly on sun drying.
Rolls of the Thai government

- Provide small dryers (30 tons/day) to Cooperatives and Farmers’ group in those areas (over 300 units existing).

- Provide soft loan to the millers and the paddy Central Market for dryers installation.

- Paddy mortgage plan.
Farmers’ Group and Cooperatives Dryers
Fluidized-Bed Dryer

- Rapid mixing of the kernel
- High heat and mass transfer rates between the air and the kernel
- High specific energy consumption
Rotary Dryers

- shell diameter: 1-2 m
- length: 15-30 m
- slope of the shell: 2-4 °
- drying air temp.: 120-280 °C
- retention time of grain: 10-20 min
Types of Paddy Dryer at Commercial Level

- Mixed Flow majority (over 60%)
- Columnar ~27%
- Fluidized Bed
- Rotary negligible
Development of agricultural machinery testing
networks in Thailand

Thai Industrial Standard Institute (TISI), Ministry of Industry is responsible for standardization of agricultural machinery. TISI was established in 1968. It is the official agency with the responsibility in the development of Thai Industrial Standards (TIS), including agricultural machinery standards.
The preparation of agricultural machinery standards is undertaken by the Technical Committee (TC). The TC, appointed by the TISI, includes representatives from Agricultural Engineering Research Institute (AERI), manufacturers, the Bank of Agriculture and Agricultural Cooperatives (BAAC), universities. Approved standards are published in the government gazette.
Agricultural machinery standards from various countries have been studied and then adapted to be suitable with Thai agricultural machines and their corresponding working conditions. Research is required to get a basic data for developing standards. Safety standard is one part of each agricultural machinery standard.
Most of agricultural machinery standards are voluntary standards.

Only small diesel engine standard is a mandatory one.

Only a few number of agricultural machinery manufacturers apply for the TISI standard certification.
Thai Industrial Standard
for
Axial Flow Rice Threshers

1. Scope

1.1 This standard specifies components and construction, requirements, mark and label, sampling and criteria for acceptance, and testing for axial flow rice thresher hereinafter referred to as "thresher".

1.2 Threshers in this standard shall use, as power source, engine, electric motor or tractor for threshing crops which are conveyor-fed through the feed board and moved parallel to the axis of the spike-tooth threshing drum. Threshed grains will be separated from foreign materials in a continuous operation.
2. Definitions

For the purpose of this standard, the following definitions apply:

2.1 THRESHING: The separation of grain from straw.

2.2 WHOLE GRAIN: Mature unbroken grain free from earhead.

2.3 UNTHRESHED GRAIN: Whole grain attached to straw after threshing.

2.4 BROKEN GRAIN: Wholly or partially cracked or broken grain.

2.5 GRAIN WITH EARHEAD: Grain attached with grain bearing spike after threshing.

2.6 GRAIN MIXTURE: The mixture of whole, broken, unthreshed grains and grain with earhead coming out of the outlet(s).

2.7 FOREIGN MATERIALS: Materials other than grain such as straw, insect, husk, weed seed, sand, gravel, stone, clay and metal chip.

2.8 NOMINAL FEED RATE: The quantity of crop fed per unit of time at which reasonable threshing efficiency can be attained.

2.9 THRESHING EFFICIENCY: The threshed grain received at all outlets with respect to total grain mixture expressed as percent by weight.

2.10 CLEANING EFFICIENCY: The whole grain with respect to grain mixture including foreign materials at main grain outlet expressed as percent by weight.
2.11 PERCENTAGE OF SPILLED GRAIN: All the grain received at all outlets other than the main grain outlet with respect to total grain mixture, expressed as percent by weight.

2.12 PERCENTAGE OF BROKEN GRAIN: The broken grain from all outlets with respect to total grain mixture expressed as percent by weight.

2.13 OUTPUT CAPACITY: The grain mixture received per unit of time at main grain outlet.

2.14 SPECIFIC OUTPUT CAPACITY: The output capacity per unit power of the power source used.

2.15 STRAW AND GRAIN RATIO: The ratio by weight of straw to grain.

2.16 POWER CONNECTIONS: Points for the installation of devices by which the motion of a power source is transmitted to or disconnected for all systems.

2.17 LENGTH OF THRESHING DRUM: End to end length of the threshing drum excluding the axle as shown in Figure 1.

![Diagram of Drum Length](image.png)

Figure 1 Length of threshing drum (clause 2.17).
3.1.1 Threshing system for threshing and for discarding straw through the straw outlet.

3.1.2 Cleaning system for separating foreign materials from threshed grain.

An example of crop flow diagram of the thresher is given in Figure 3.

Figure 2: Example of thresher components (clause 3.1)
Figure 3: Crop flow diagram of thresher (clause 3.1)
3.2.1.2 Means of lubrication for moving components and points of contact between metal parts shall be provided.

3.2.1.3 All points requiring frequent lubrication and cleaning shall be easily accessible.

3.2.2 All metal components except the threshing drum, the inner surface of concave, and transport instruments shall be painted or finished for protection against rust.

3.2.3 Safety for operator of the thresher shall be ensured as follows:

3.2.3.1 Protruding fasteners shall be avoided.

3.2.3.2 Any sharp corners shall be avoided.

3.2.3.3 Guards shall be provided to prevent accidental contact of operators in the transmission system. They shall be so designed as not to hinder in the adjustment, servicing and operation of components, and shall not be easily removed without the aid of tools.
4. Requirements

4.1 Components and instruments shall comply with the following:

4.1.1 Feed board
The feed board shall be made from steel sheet of at least 1.2 mm thickness.

The shortest normal distance measured in a horizontal plane from the tip of the threshing teeth to the outer edge of the feed board (a) shall not be less than 750 mm, as shown in Figure 4. Compliance is checked by measurement.

4.1.2 Threshing drum and teeth
4.1.2.1 When tested as in clause 7.1.2.1, threshing drum shall statically balance.
Figure 4 Normal distance from threshing teeth to feed board (clause 4.1.1)
4.1.2.2 Threshing drum shaft shall be made from steel having a tensile strength of 451 to 755 MPa and a hardness of 69 to 100 HRB. Compliance is checked by the test of clause 7.1.2.2.

4.1.2.3 Threshing teeth shall be made from hardened low alloy steel averaging 32 to 40 HRC in hardness. Compliance is checked by the test of clause 7.1.2.3.

4.1.2.4 One end of the threshing tooth shall be fastened to the drum by means of screw thread conforming to TIS 159, "General purpose ISO metric screw threads and selected sizes for screws, bolts and nuts", having a pitch of not less than 1.75 mm and a screw length not less than 25 mm. Where the threshing drum is not threaded, a spring lock washer shall be attached to all threshing teeth. Compliance is checked by visual inspection and by inspecting the diameter and pitch using a go and no-go gauge.

4.1.3 Bearing
Bearing shall be of a type provided with seal for adequate protection against the ingress of dust. Compliance is checked by visual inspection.

4.1.4 Power transmission V-belt
TIS 146, "Power transmission V-belt" shall be complied with.
<table>
<thead>
<tr>
<th>ตัวอย่างที่</th>
<th>ความแข็งรอยแคลสส์เกล C</th>
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หมายเหตุ: ความแข็งรอยแคลสส์เกล C 32-40 HRC
การทดลอง/วิเคราะห์ : เหล็กกลม
วิธีการทดลอง/วิเคราะห์ : ความต้านทานแรงตึง และความแข็ง
ภาวะการทดลอง : อุณหภูมิ 29 °C ความชื้นอัตโนมัติ 65 %
ผลการทดลอง/วิเคราะห์ : -

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<th>ตัวอย่าง</th>
<th>ขนาด (mm.)</th>
<th>ความต้านแรงดังที่จุดกระแทก (kgf/mm²) (MPa)</th>
<th>ความต้านแรงดังสูงสุด (kgf/mm²) (MPa)</th>
<th>ความยืด (%)</th>
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<td>1</td>
<td>Ø 18.84</td>
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<td>63.72 (637.2)</td>
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<tr>
<td>2</td>
<td>Ø 18.92</td>
<td>52.73 (527.3)</td>
<td>63.71 (637.1)</td>
<td>3.56</td>
</tr>
<tr>
<td>3</td>
<td>Ø 19.00</td>
<td>38.96 (389.6)</td>
<td>49.13 (491.3)</td>
<td>8.80</td>
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หมายเหตุ : ชุดนายนกเกินงา Gage 451 - 755 เมกอนิวตัน (MPa)
<table>
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<tr>
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<tr>
<td>3</td>
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</tbody>
</table>

*หมายเหตุ: ตามมาตรฐาน A1-100 HRB*
4.2 Efficiency

4.2.1 No-load condition

When tested in accordance with clause 7.2.3.1, the following shall be ensured.

4.2.1.1 The thresher shall operate without shock or blockage in the threshing and the cleaning systems;

4.2.1.2 Rotating or oscillating components shall operate smoothly without undue knocking or rattling sound as a result of abrasion or imbalance;

4.2.1.3 None of the components or instruments shall be damaged. Fastening connections between different components by means of rivets, bolts or welding shall be such that they will not get separated or loosened.

4.2.2 Load condition

When tested in accordance with clause 7.2.3.2,

4.2.2.1 Threshing efficiency shall not be less than 99% ;

4.2.2.2 Cleaning efficiency shall not be less than 97% ;

4.2.2.3 Percentage of spilled grain shall not exceed 4 ;

4.2.2.4 Percentage of damaged grain shall not exceed 2 ;

4.2.2.5 Specific output capacity shall not be less than 120 kg/hr/kw ;

4.2.2.6 The running of the thresher as given in clauses 4.2.1.1, 4.2.1.2 and 4.2.1.3 shall still be maintained.
7.2 Efficiency

7.2.1 General requirements for calculations and measuring devices used for the tests shall be as follows:

7.2.1.1 Revolution speed

Apparatus for measuring revolution speed shall be accurate to within 2 %.

7.2.1.2 Weight

Weighing apparatus shall be accurate to 0.1 g.

7.2.1.3 Straw and grain ratio

Take five samples of the crops each weighing about one kilogram. Separate the grains from stalks manually for each sample. Take the mass of grain and straw separately for each sample, and calculate their ratio. The average of the five samples shall be taken as the straw and grain ratio.

7.2.1.4 Weight of crop bundle and length of cut crop

Ten bundles of cut crop shall be used. Weigh each bundle, and obtain the average length of cut crop from a number of these samples.
7.2.1.5 Moisture content of grain
Use the samples as of clause 7.2.1.3. Determine its moisture content in accordance with the method specified in ISO 712.

7.2.1.6 Sampling of threshing output
Use a container of a size sufficient to permit single collection of all samples within the specified time. Sampling at straw outlet and foreign material outlet should be carried out using a sack or any other apparatus that permits the air to pass through.

7.2.1.7 Analysis of samples
Manual separation or standard analysis instrument shall be applied.
7.2.1.3 ผลการทำต่อชั้นเปลือก

<table>
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<th>เลขชั้น</th>
<th>ต้นชั้นกิโลกรัม</th>
<th>ต้นเปลือก</th>
<th>ต้นสตรอว์</th>
<th>ผลรวม</th>
<th>ผลรวม % (ในก.บ.)</th>
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<td>5</td>
<td>644.5</td>
<td>359.5</td>
<td>662.16</td>
<td>20.9</td>
<td>ผลรวม 20% ก.บ.</td>
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7.2.1.4 น้ำหนักพืชชนิดและความยาวของต้นชั้น
<table>
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<tr>
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The National Agricultural Machinery Center (NAMC) was established in 1979 organized under Research and Development Institute at Kamphaengsaen, Kasetsart University.

The main functions of the center was

1) Testing and Standardization

2) Responsibilities to testing of agricultural machines either locally fabricated in Thailand or imported from abroad and collaborating with the Thai Industrial Standards Institute in standardizing agricultural machinery testing.
Future collaboration

Establishing a regional network for testing agricultural machinery will be useful among national agricultural machinery testing agencies and institutes of member countries for efficient use of agricultural machinery and promotion of green agricultural technology.
THANK YOU