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Climate-Smart Agricultural Mechanization in Malaysia: Solutions for Challenging Soil and Field Conditions

Mohamed Fauzi Md Isa, PhD
Senior Research Officer
Malaysian Agricultural Research and Development Institute (MARDI)

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National mechanization overview and needs

Malaysia’s mechanization priorities

Rice production

High mechanization, but wet-field operations remain sensitive to soil condition and trafficability.

Emerging crops

Mechanization is expanding for grain corn and horticultural production under diverse field conditions.

Key need

Machinery and field systems that maintain timely operations under variable rainfall, wet soils and limited workable field windows.

Priority: Suitable machinery + soil condition + water management

Climate resilience requires reliable field access without excessive sinkage, rutting or soil disturbance.

National initiatives: climate resilience and crop residues

Case focus: wet and soft paddy soils

Wet / saturated fields → Low soil bearing capacity → Sinkage & rutting → Poor trafficability → Delayed field operations → Residue left in field or burnt

Malaysia case evidence

Soft paddy fields are characterised by wetter soil conditions and lower dry density, increasing susceptibility to machinery-induced deformation and trafficability constraints.

Source: [Mohamed Fauzi, M.I.,et al., 2023, 2025; MADA, Kedah,]



Link to crop residue management

When fields are too soft for balers and collection machines, straw is more likely to be left in the field or burnt. Trafficability therefore also constrains sustainable residue management.

Engineering implication: trafficability should be treated as a mechanization design parameter—not only as a soil problem.

National initiatives: soil–water–machine solutions

Integrated engineering and mechanization response

1 Water & drainage management

Improve field drainage and water-level control to widen reliable machinery operating windows.

2 Machinery adaptation

Appropriate machine mass, tyres/tracks and low-ground-pressure configurations for weak soils.

3 Soil improvement

Cut-and-fill: replace weak soil with compacted fill at the required depth to improve bearing capacity.

4 Smart field monitoring

Soil moisture and field-condition sensing to support trafficability assessment and operation timing.

5 Crop residue management

Mechanized collection, incorporation and productive use of residues with machines suited to wet fields, reducing open burning.

6 Conservation operations

Reduce unnecessary passes, rutting, compaction and soil disturbance while maintaining timeliness.

SOIL & WATER + APPROPRIATE MACHINERY + CROP RESIDUE MANAGEMENT → resilient agrifood systems

Mechanized rice straw collection: mini baler field test

Tractor-mounted mini baler operating on a harvested paddy field

1.67 km/h

Operating speed

Gear 1-1 at 2,000 engine rpm / 500 PTO rpm



Field operation MADA, Kedah



Bale size: 70 cm length × 50 cm diameter

98.5 kg/m³

Bale density

Compact bales still give dense, transportable material

13.5 kg

Average bale weight

Allows easy manual handling if necessary

Key point: compact, mechanized collection reduces manual handling of loose straw and offers an alternative to open burning.

Implication: compact bales are easier to handle, transport and use productively than loose straw.

Conventional vs. MARDI-proposed straw baling system

Lower capital cost and lighter equipment for smallholder paddy fields

Conventional baling system

Equipment
Tractor + large round baler

Indicative cost
High capital cost (> RM 100k)

Bale output
Large 1.2 m × 1.0 m bales, about 150 kg

Field requirement
High horsepower and dry, firm ground

MARDI-proposed mini baler system

Equipment
Tractor + mini baler

Indicative cost
Lower capital cost (~RM 40k)

Bale output
Compact 70 cm × 50 cm bales, about 13.5 kg

Field requirement
Smaller, lighter system; works directly on the stubble field

Link to soft soils: lighter, lower-horsepower collection equipment may widen the window for straw collection in wet paddy fields (to be verified with trafficability data).

Opportunities for regional cooperation

Three priorities for regional cooperation

Joint R&D

Joint evaluation of low-ground-pressure machinery, traction, sinkage and trafficability under soft and wet field conditions.

Knowledge exchange

Exchange practical experience on climate-smart paddy mechanization, drainage, conservation practices and residue management.

Digital decision support

Develop regional approaches for soil/field monitoring and decision support for suitable machinery operating windows.

Potential regional value

Shared testing protocols • comparable field indicators • adaptable machinery solutions • joint demonstrations & capacity building

THANK YOU

OFFICIAL WEBSITE
MALAYSIAN AGRICULTURAL RESEARCH AND DEVELOPMENT INSTITUTE
Ministry of Agriculture and Food Security

Mohamed Fauzi Md Isa, PhD
Tel: +60122188711
Email: fauziisa@mardi.gov.my
Website: https://www.mardi.gov.my/en/

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