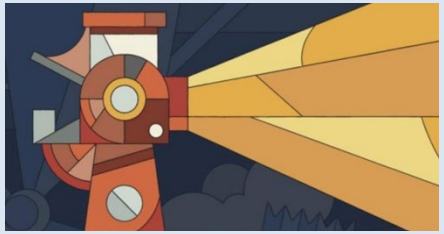


AGRILEVANTE by eima

CLUB OF BOLOGNA

strategies for the development of agricultural mechanisation

FEDER UNACOMA
Italian Agricultural Machinery Manufacturers Federation

34th Members' Meeting of the «Club of Bologna

Mechanisation and Technologies for New Farmers Needs

11-12 October 2025
Bari, Italy

Evolving Farmers' Needs as Drivers of Next-Generation Tractor Design in Africa, Asia, and Latin America

Prof. Karim Houmy (FAO International Consultant, karim.houmy@fao.org),
Mr. Josef Kienzle (FAO Mechanization Team leader, Josef.Kienzle@fao.org)

Prof. Karim Houmy, FAO international consultant with over 30 years of experience as a professor in the Department of Agricultural Engineering at the Hassan II Institute of Agronomy and Veterinary Medicine in Rabat, Morocco.

Mr. Josef Kienzle leads the Sustainable Agricultural Mechanization team at FAO Headquarters in Rome

Outline

- Introduction
- Current situation of Tractors in Africa, Asia, and Latin America
- Key Drivers of Farmers' Changing Needs
- Design Principles for Next Gen Tractors
- Barriers to Scaling Next-Gen Tractor Designs
- Scenario Paths & Enablers for Tractor Growth
- Recommendations & Next Steps
- Conclusion

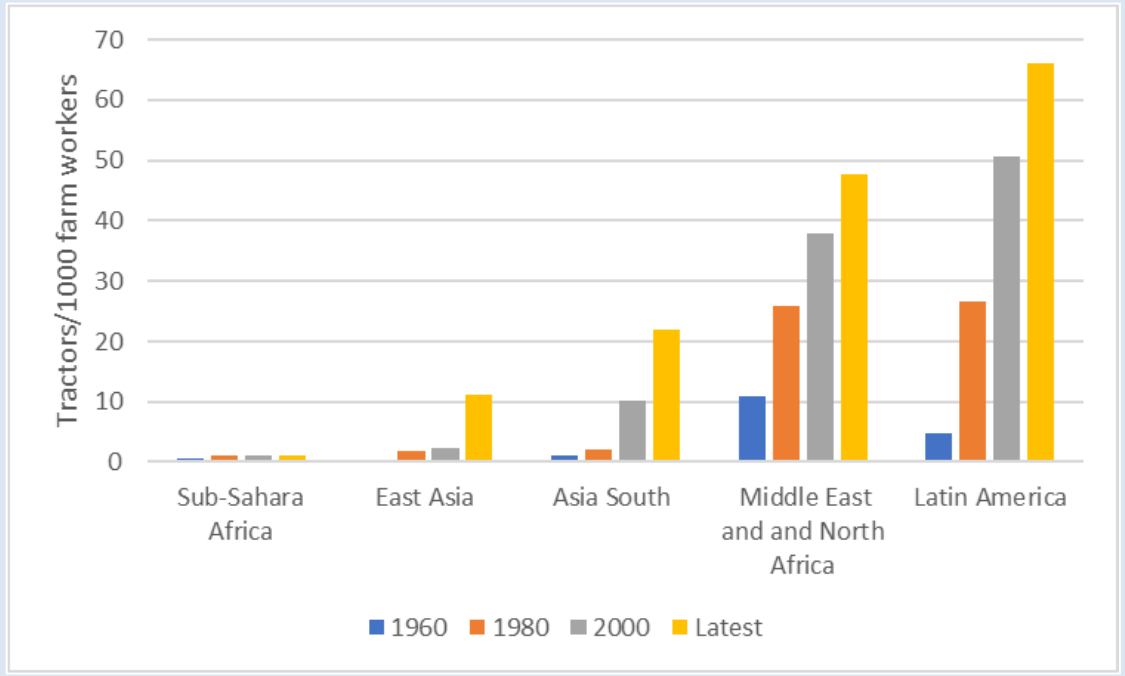
Introduction

- Technology should follow farming—not the other way around.”
- The evolution of agriculture in Africa, Asia, and Latin America is reshaping what farmers need from tractors.
- Understanding farmers’ realities is key to shaping meaningful innovation.
- Today’s forces , like labor decline, climate pressures, and demand growth, make rethinking tractor design urgent.

Future tractor design must be demand-driven, not just tech-driven

Current situation of Tractors in Africa, Asia, and Latin America

- At independence in the 1960s, sub-Saharan Africa had mechanization levels comparable to , or higher than, many Asian countries
- Over the next five decades, tractor use increased significantly in Latin America & the Caribbean
- Next came rapid growth in the Middle East, North Africa, and then in Asia
- In contrast, sub-Saharan Africa's tractor use has remained stagnant and much lower than those regions

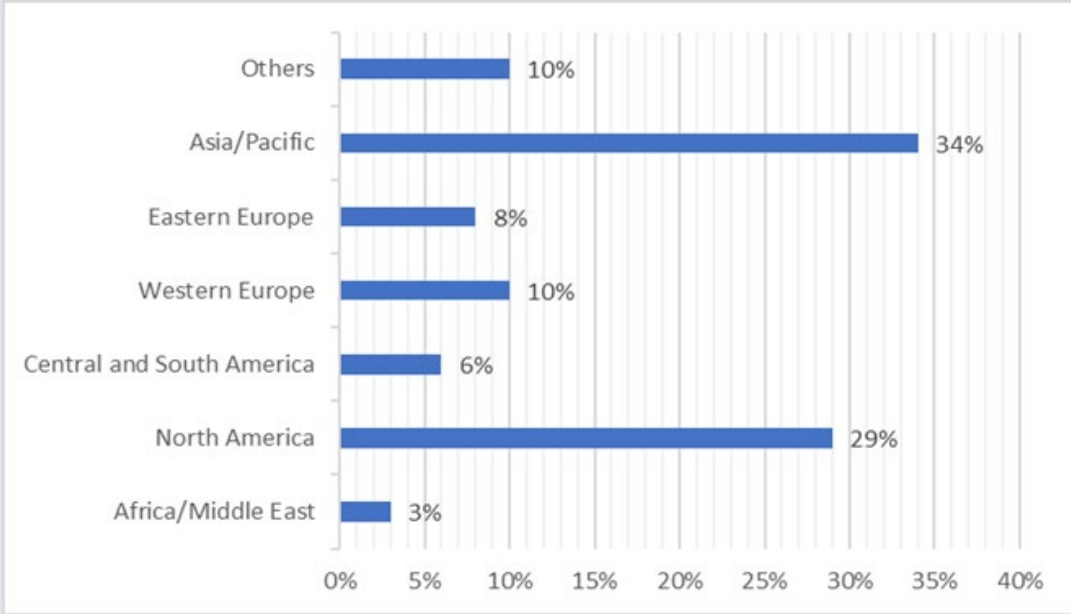


Tractors / 1000 farm workers

(Fuglie et al. 2019). The latest is mostly 2009

Agricultural machinery: a global industry

- Africa and the Middle East represent only ~3% of the global agricultural machinery market.
- Major Western manufacturers have tended to ignore Africa because their machines are designed for large, capital-intensive farms.
- The African market has long been seen as shrinking or unattractive, dissuading investment in marketing and product adaptation



Global market of agricultural machinery by geographical area
(CEMA, 2022)

Current Tractor Technology Landscape in Africa, Asia & Latin America

- Power & Engine
  - Small to medium power tractors (often < 80 HP)
  - Diesel engines common;
  - Emission regulations are emerging in some Asia / Latin American markets, but lag behind developed markets.
- Transmission & Hydraulics
  - Mostly manual transmissions;
  - Standard PTO shafts and hydraulic systems are common to support implements and attachments.
- Operator Comfort & Safety
  - Open or semi-enclosed cabs are still common; full enclosed, climate-controlled cabs more frequent only in higher value or commercial farms
  - Basic safety features (ROPS, seat belts) are variably installed
- Technology & Connectivity
  - Limited GPS, telematics mostly on large farms
  - Poor connectivity limits IoT adoption
- Maintenance & Affordability
  - Local repairs common; spare parts scarce
  - Cost barriers lead to rental models

Key Drivers of Farmers' Changing Needs

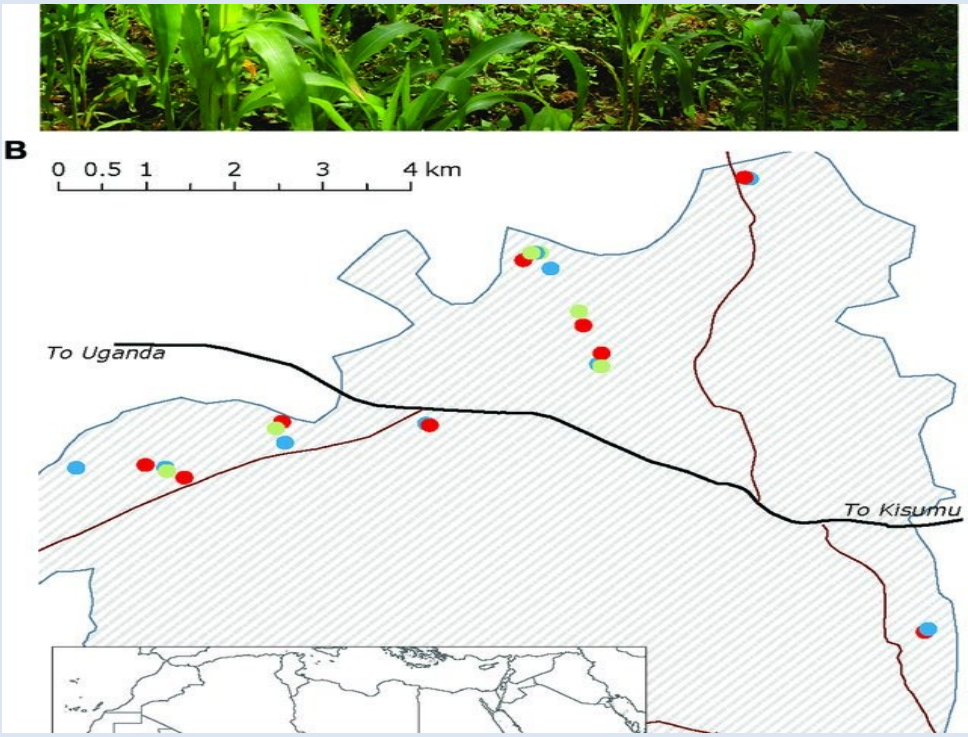
Smaller, Fragmented Landholdings

Key drivers:

- Many smallholder farms consist of multiple tiny plots rather than one large field
- Fragmentation increases transit time and operational inefficiency
- Large tractors or heavy machines become uneconomical in fragmented layouts

Farmers' needs:

- Compact, maneuverable machines suitable for narrow/irregular plots
- Modular or interchangeable tools for quick adaptation
- Fast switching and minimal downtime between plots



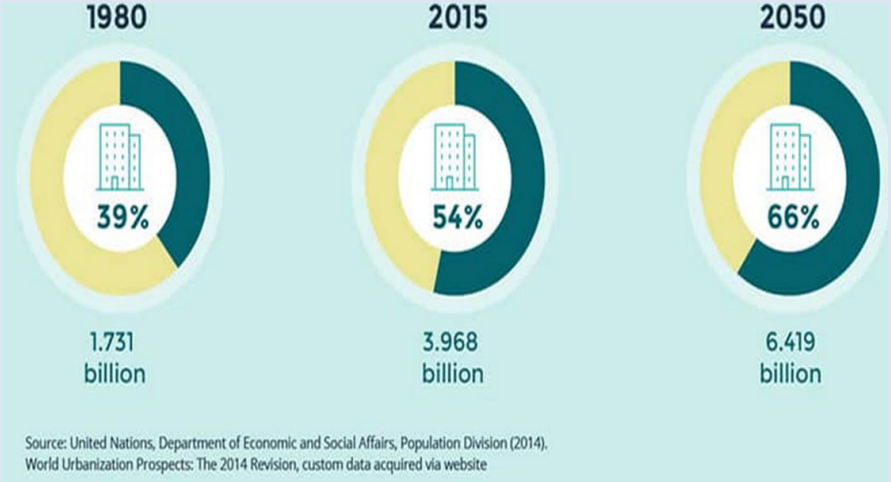
Labor Shortages & Rising Labor Costs

Key drivers:

- Rural migration, demographic changes, and urbanization are reducing the supply of rural labor.
- Seasonal peaks (planting, weeding, harvest) face acute labor bottlenecks
- Labor costs escalate, making manual work less competitive

Farmers' needs:

- Machines offering higher hourly throughput
- Lower operator dependency / automation (fewer operators needed)
- Ease of operation, so less skilled or fewer people can run equipment
- Reduced downtime and fast task switching to maximize productive time



Crop diversification / mixed cropping

Key drivers:

•Mixed cropping / intercropping and crop rotations are common in many smallholder systems

•Different crops in the same field or season require differing row geometry, depth, heights

•Rigid implements may damage neighboring crops or be inefficient

Farmers' needs:

- Modular / swappable attachments
- Adjustable configurations (row width, ground clearance, tool spacing)
- Fast transitions between tasks

Climate & environmental pressures

Driver / Pressures:

- More extreme weather (droughts, floods, erratic rains)
- Degraded soils, erosion, salinity
- Shift toward conservation / climate-smart practices
- Emissions & fuel concerns

Farmers' Needs:

- Resilient, adaptive machinery
- Low-disturbance tools (no-till, residue friendly)
- Propulsion shift: electric / hybrid
- Rapid response / narrow operating windows

Mk1 e-tractor, pilot project in Rwanda

Limited capital / access to credit

Driver / Constraints:

- High upfront cost of tractors & implements
- Seasonal, irregular incomes; cash flow mismatch
- Weak agricultural credit systems & high interest / collateral demands
- Reluctance by lenders to assume risk,

Farmers' Needs :

- Lower capital entry, shared models,
- Flexible / seasonal financing (lease)
- Credit guarantees, risk sharing, local financing innovations

Weak infrastructure & service networks

Driver / Constraints:

- Poor rural roads (unpaved), long travel distances
- Limited repair shops & skilled mechanics
- Weak spare parts supply chains
- Gaps in energy, fuel, or charging infrastructure
- Limited connectivity for support / diagnostics

Farmers' Needs:

- Portable and robust machines suitable for rough terrain
- Field-serviceable / modular components
- Self-diagnostics & remote support
- Decentralized service networks

Women’s involvement & inclusiveness

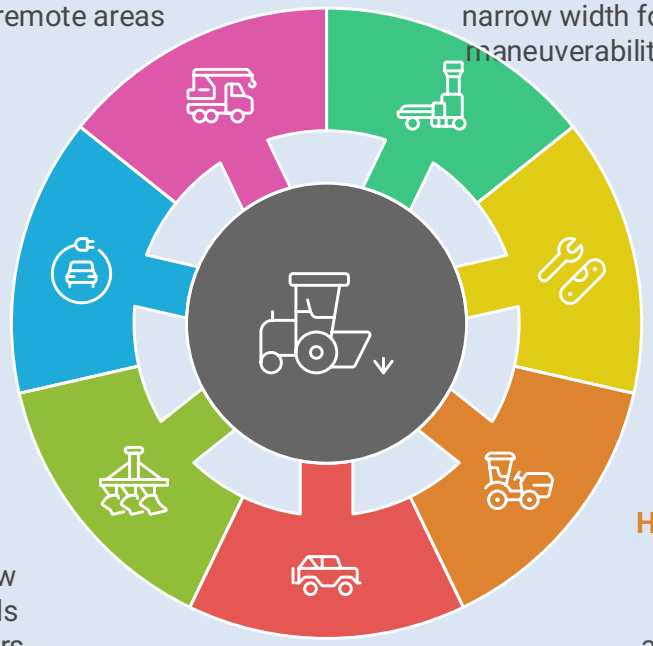
Driver / Context:

- Technology built with male assumptions
- Limited access to credit, land, training
- Fewer opportunities in mechanization services

Farmers’ Needs :

- Ergonomic design for diverse bodies (step height, handle reach)
- Light / manageable machines for women operators
- Gender-sensitive training & support programs
- Tailored finance/leasing for women

Design Principles for Next Gen Tractors



Serviceability

Tractors with self-diagnostics and modular parts for remote areas

Compact Design

Tractors with adjustable chassis and narrow width for maneuverability

Clean Propulsion

Tractors with electric or hybrid systems for low emissions

Modularity

Tractors with quick-change mounts and modular attachments

Conservation

Tractors with low disturbance tools and no-till seeders

High Throughput

Tractors with assisted automation and ergonomic controls

Resilience

Tractors with adaptive traction and durable materials

Barriers to Scaling Next-Gen Tractor Designs

- Low ROI / seasonal demand, poor returns in off-season
- Policy & institutional gaps — weak governance, import barriers, tenure risks
- Ecosystem fragility — missing parts, repair, supply chains, training
- Behavioral & info barriers, low trust

Scenario Paths & Enablers for Tractor Growth

Baseline	• modest growth with constraints persisting
Optimistic	• accelerated adoption if enablers align
Leapfrog / Disruptive	• transformational shifts (modular robotics, electric fleets) under strong enabler alignment

Enablers

- Policy & Institutional Reform
- Finance & Credit Innovation
- Service Ecosystem & Parts Network
- Digital / Technology Infrastructure
- Partnerships & Scaling Models

Recommendations & Next Steps: Enabling Next-Gen Tractor Uptake

- **Designers / Engineers:** Co-design with farmers; emphasize robustness, modularity, local adaptation
- **Governments / Policymakers**: Reform import tariffs, standards, subsidies; support mechanization strategies
- **Funders / Investors / Donors:** Provide de-risking mechanisms, pilot financing, support to local supply chains
- **Service Providers / Entrepreneurs:** Scale mechanization-as-a-service models; build spare-parts & repair networks
- **Extension / Training:** Deploy mechanization extension agents; run demonstration plots; support capacity building.

Conclusion

Core Message: Tractors must respond to farmers' evolving real needs

Key Takeaways:

- Needs like compactness, modularity, resilience, serviceability, affordability guide design
- Even excellent designs must overcome financial, infrastructural, capacity, and institutional barriers
- With aligned policy, finance, and ecosystems, transformational growth is possible