CGIAR SUSTAINABLE FARMING

Agricultural Mechanization Hire Services Provision Models, Performance and Challenges in Ethiopia

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CGIAR Sustainable Farming Science Program Report

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The CGIAR Sustainable Science Program forms a part of CGIAR's new Research Portfolio, addressing key challenges in agri-food systems by fostering efficient production of nutritious foods and safeguarding the environment to create fair employment opportunities, as we simultaneously tackle climate change, soil degradation, pests, diseases, and desertification. Its research is being implemented by CGIAR researchers from CIMMYT and ICRISAT, in close partnership with Ethiopian Ministry of Agriculture and Regional Bureaus.

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About CGIAR Sustainable Science Program Report

This research was conducted as part of the CGIAR Sustainable Farming Science Program. This research is being implemented by CGIAR researchers from CIMMYT and ICRISAT in close partnership with *Ethiopian Ministry of Agriculture and Regional Bureaus*. CGIAR is a global research partnership for a food-secure future. Its science is carried out by 15 Research Centers in close collaboration with hundreds of global partners. www.cgiar.org

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About CGIAR Sustainable Farming Science Program

The CGIAR Sustainable Farming Science Program will address key challenges in agrifood systems by fostering efficient production of nutritious foods and safeguarding the environment to create fair employment opportunities, as we simultaneously tackle climate change, soil degradation, pests, diseases, and desertification.

Summary

This report examines the structure, performance, and operational challenges of mechanization hire service provision in Ethiopia using survey data from 326 service providers across five regions. The regional distribution shows a strong concentration of service providers in Oromia, which accounts for over 60% of respondents, followed by Amhara and Central Ethiopia, while representation from Sidama remains very limited. This spatial pattern reflects both the uneven development of mechanization markets and regional differences in agricultural intensity, infrastructure, and investment.

Mechanization service provision in Ethiopia is dominated by privately owned enterprises, with individual ownership model accounting for the majority of the hire services businesses. Group-based models such as cooperative unions, farmer groups, and youth groups operate at a relatively lower level. Service providers are generally middle-aged, with an average age of 43 years, and possess moderate levels of formal education, suggesting a combination of experience-based knowledge and basic technical capacity. However, female participation as individual service providers remain very low, indicating gender barriers in asset ownership, access to finance, and entrepreneurship within the mechanization sector.

The experience profile of service providers points to a maturing but constrained market. 50% of the providers have more than five years of experience, indicating that mechanization hire services are well established and have operated sustainably over time. At the same time, a sizeable share entered the business within the past two to four years, reflecting earlier periods of growth and investment. Recent entry, however, appears to have slowed, likely due to rising machinery costs associated with currency devaluation and increased capital barriers.

In terms of service focus, mechanization remains highly concentrated in land preparation, with limited but growing diversification into harvest and post-harvest operations such as threshing and combining. Most target client of the service providers are semi-commercial farmers, where farmers cultivate primarily small to medium-sized plots (1–5 ha) and balance household consumption with market production. Subsistence farmers and fully commercial farms represent only a small share of clients, reflecting differences in affordability, scale, and reliance on owned machinery. Together, these patterns highlight the central role of mechanization services in supporting transitional smallholder systems rather than agricultural extremes.

Despite growing demand, service provision is constrained by significant operational challenges. Machinery breakdowns, long repair times, and limited access to spare parts and fuel are widespread, reducing profitability, service reliability and limiting the capacity of providers to expand or diversify. Technology acquisition is largely driven by private investment and bank credit, with relatively limited reliance on subsidies or public support, underscoring both the entrepreneurial nature of the sector and its exposure to financial and operational risks.

1. Introduction

Agricultural mechanization is widely recognized as a critical driver of productivity growth, rural transformation, and food security in developing economies (Pingali, 2007; Diao et al., 2016). By substituting or complementing human and animal labor, mechanization can enhance timeliness of operations, reduce drudgery, improve input use efficiency, and increase cropping intensity all of which contribute to sustainable agricultural development (FAO, 2019). In sub-Saharan Africa, where farming remains predominantly manual and labor-constrained, the adoption of mechanized technologies has been slow and uneven, often limited by factors such as access to finance, farm size fragmentation, infrastructure deficits, and inadequate after-sales support (Sims & Kienzle, 2016; Van Loon et al., 2020).

Ethiopia, with its large agricultural sector employing nearly 80% of the population, has identified mechanization as a strategic priority in its national development agenda (Ethiopian Ministry of Agriculture, 2021). In contrast Ethiopia often emphasizes general entrepreneurship rather than machinery diagnostics, preventive maintenance, or precision operation (FAO, 2023; Takeshima et al., 2019).

In recent years, the country has experienced a notable expansion in the supply and use of agricultural machinery, particularly through the emergence of private and cooperative-based mechanization service providers (Berhane et al., 2018). These service providers often offer tractor hire for tillage, planting, harvesting, and threshing play a vital role in facilitating access to mechanization for small and medium-scale farmers who cannot afford to own machinery. However, the growth and effectiveness of such service markets are influenced by a complex set of factors, including operator characteristics, business models, access to inputs and support services, and the socio-economic and biophysical context in which they operate.

Despite policy emphasis, there remains limited empirical understanding of the profile, operational challenges, and service delivery models of mechanization service providers in Ethiopia. Existing studies highlight regional disparities, gender gaps, and logistical constraints, but few offer a comprehensive analysis of service provider characteristics, their linkages with clients, and their dependence on external support systems (Kansanga et al., 2021; Kaminski & Christiansen, 2014). Such insights are essential for designing targeted interventions that can strengthen the mechanization service ecosystem, enhance smallholder access, and promote inclusive agricultural growth.

This study addresses this knowledge gap by analyzing survey data from 326 mechanization service providers across five major regions of Ethiopia. The report examines key dimensions including regional distribution, gender composition, education and experience levels, farm and cropping systems, service provision patterns, supply chain access, business orientation, and client profiles. Through this analysis, we aim to provide evidence-based insights that can inform policymakers, development partners, and private sector actors in their efforts to build a more efficient, equitable, and sustainable mechanization service sector in Ethiopia.

2. Methodology

This study employs a descriptive and analytical research design to examine the different mechanization service providers model in Ethiopia, how they operate, their performance, characteristics, challenges and enabling environments. The methodology is structured to provide a comprehensive overview of the different mechanization models using both quantitative and qualitative survey data.

2.1. Study Area and Sampling

The study was conducted across five major agricultural regions of Ethiopia: Amhara, Central Ethiopia, Oromia, Sidama, and South Ethiopia. These regions were purposively selected due to their significant contribution to national agricultural output and their varying levels of mechanization adoption. Mechanization service providers were surveyed using a multi-stage stratified random sampling technique: In the first stage, zones and districts (*woredas*) with known mechanization activity were identified in consultation with regional bureaus of agriculture. In the second stage, service providers were stratified by type of ownership (private, cooperative, group-based) and location (urban/rural). A proportional sampling approach was used to ensure representation across regions and business types based on proportional to sample size.

2.2. Data Collection

Primary data collected through structured questionnaires administered via face-to-face interviews between [October 15 to November 25, 2025]. The questionnaire was developed in English, and communicated with languages (Amharic, Afaan Oromo, Wolaita and Gamo), and pre-tested for clarity and relevance.

The survey instrument covered the following key modules: Owner/ manager characteristics, Farming system, Business organization, partners and collaboration, resources, flow of services, market segmentation, service and value proposition, hire charges, cost and revenue structure, access to finance, market performance, profitability, management capacity, customer satisfaction, business growth and enabling environment.

Secondary data from regional agricultural offices, the Central Statistical Agency of Ethiopia, and published literature were used to contextualize the findings.

2.3. Data Analysis

Data was cleaned, coded, and analyzed using Stata, and Microsoft Excel. Both descriptive and inferential statistical techniques were applied.

Descriptive Statistics: Frequencies, percentages, means, medians, ranges, and standard deviations were calculated to summarize demographic, farming system, business performance, and operational variables.

Graphical Representations: Bar charts, pie charts, and tables were generated to visualize distributions and trends.

2.4. Ethical Considerations

Informed consent was obtained from all participants prior to data collection. Confidentiality was maintained through anonymous coding of responses. The study adhered to ethical guidelines for socio-economic research as outlined by the Ethiopian National Research Ethics Review Committee.

Limitations

The study's regional coverage, while broad, may not capture highly localized variations in mechanization access. Self-reported data such as distances, income, and client numbers etc. may be subject to recall or estimation bias.

3. Results and Discussions

3.1. Distribution of Mechanization Service Providers

Table 1 illustrates the regional distribution of mechanization service providers interviewed across the five regions in Ethiopia. A total of 326 service providers is recorded. Most respondents were from Oromia Region, accounting for 199 service providers (61%), reflecting the high concentration of mechanization activities in the region followed by Amhara region with 62 (19%) service providers, Central Ethiopia with 35 (11%), South Ethiopia with 28 (9%) and 2 (1%) Service providers from Sidama Region. Overall, the regional distribution indicates a strong representation from Oromia, with moderate coverage in Amhara and Central Ethiopia, and limited representation from Sidama.

TABLE 1 MECHANIZATION SERVICE PROVIDERS SURVEYED BY REGION, ZONE AND DISTRICTS

Region	Zone	Number districts	Number of respondents	Percent
Oromia	Arsi	5	70	61%
	West Arsi	4	65	
	Bale	4	51	
	East shewa	5	13	
Amhara	North Gojjam	3	7	19%
	Awi	1	1	
	North Shewa	6	20	

	West Gojjam	2	10	
	West Gondar	1	14	
	Centeral Gondar	1	3	
	Welkait Tegedie Setit Humera	1	3	
	South Gondar	1	4	
Central Ethiopia	Halaba	4	17	11%
	East Gurage	3	8	
	Silite	3	10	
South Ethiopia	Wolaita	5	15	9%
	Gamo	4	13	
Sidama	North Sidama	1	2	1%
Total number of districts		54	326	

3.2. Owners/Managers characteristics

Age and Education Status of Mechanization Service Providers

Table 2 summarizes the age and education characteristics of mechanization service providers. The average age is 43 years, with ages ranging from 19 to 80 years, indicating participation from both young and elderly providers. The median age is 42, and the standard deviation of 11 years shows moderate variability in age distribution.

In terms of education, service providers have an average of 11 years of schooling, ranging from no formal education (0 years) to 19 years, which corresponds to higher education levels. The median education level is 10 years, and the standard deviation of 4 years suggests comparatively lower variation in schooling levels than in age. Mechanization service providers are generally middle-aged with moderate educational backgrounds, though both age and education levels vary across the different models.

Gender Distribution of Mechanization Service Providers

Table 2 presents the gender composition of mechanization service providers in the study area. Out of a total of 326 service providers, 54 (17%) business owned by a group both men and women (e.g. cooperative unions, farmer groups, women and youth groups), while the rest 272 (3% female) are individual service providers. This indicates as an individual service provision model is dominated by male, with limited women engagement.

While women clearly benefit as users of mechanization services, their participation as service providers remains very limited. This pattern mirrors findings from previous studies showing that mechanization initiatives often reinforce existing gender inequalities in asset ownership and entrepreneurship unless deliberate gender-responsive measures are adopted (UN Women, 2020; FAO, 2022). Barriers include limited access to finance, technical training, land, and restrictive social norms.

TABLE 2 DEMOGRAPHY OF THE SERVICE PROVIDERS

Socioeconomic variables	Average	Min	Max	StD	Median
Age	43	19	80	11	42
Education in years	11	0	19	4	10
Gender category of the respondents					
54 group owned (Male and female)			272 individually owned business (3% female)		
Have you accessed any formal training related to mechanization?					
Yes 170 (52%)			No 156 (48%)		

Access to training

Table 2 above shows moderate access to training among respondents. About half of the mechanization service providers have received formal training, while the remaining around 48% have not received any formal mechanization-related training, a gap that has important implications for the sector, as limited technical and

business skills among untrained providers can contribute to inefficient machinery use, higher breakdown rates, increased operating costs, and reduced service quality, ultimately affecting the sustainability and scalability of mechanization hire services. The finding underscores the need for expanded, inclusive, and more targeted training programs, especially in mechanization-specific technical skills, to improve overall service effectiveness and sustainability.

Experience in the Hire Service Business

Table 3 presents the distribution of service providers based on their years of experience in the hire service business.

The distribution of years of experience among mechanization service providers indicates a mixed but maturing market. A substantial share of providers (50%) have more than five years of experience, showing that mechanization hire services are well established and have been operating sustainably over time. At the same time, the largest proportion of respondents (32%) falls within the 2–4 years of experience category, suggesting a notable wave of entry in recent years, likely driven by growing demand for mechanized services and earlier investment-friendly conditions.

In contrast, only 18% of providers have less than two years of experience, with just 6% entering the business within the last year. This pattern suggests that while entry into the sector was relatively strong in previous years, the pace of new entry has slowed recently, most likely due to the recent devaluation of the Ethiopian birr, which significantly increased the cost of imported agricultural mechanization technologies and raised the capital barriers for new entrants.

TABLE 3 NUMBER OF YEARS/EXPERIENCE IN THE MECHANIZATION HIRE BUSINESS (%)

Years of experience in the business	Percent
Over 7 years	25
5-7 years	25
2-4 years	32
1-2 years	12
Less than a year	6

3.3. Farming System

Production System

Figure 1 shows that 86% of mechanization service providers operate in semi-commercial or mixed farming systems dominated areas, where client farmers produce both for market sale and household consumption, while only 8% serve primarily subsistence farmers and 6% focus on commercial farms. The dominance of semi-commercial clients indicates that mechanization services are most strongly demanded in transitional farming systems, where farmers face labor constraints and timeliness challenges but still rely partly on household production. The relatively low share of commercial farms reflects both their limited number in Ethiopia and their higher level of on-farm technology ownership, which reduces reliance on hired mechanization services. Conversely, the small proportion of subsistence farmers served suggests continued barriers related to affordability, farm size, and limited market incentives.

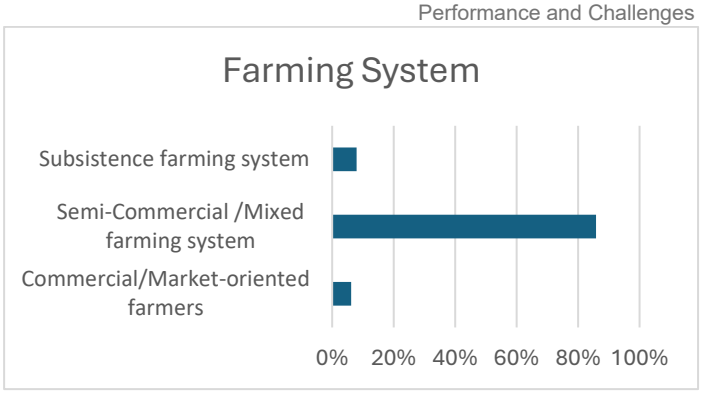

FIGURE 1 FARMING SYSTEM OF MECHANIZATION SPS OPERATION AREA

Farm Size

The responses from mechanization service providers indicate that the areas they serve are predominantly characterized by smallholder farming systems (Figure 2). According to the providers, the typical farm size in their service areas is most commonly 1–3 ha, reported by 192 respondents (59%), followed by 3–5 ha as indicated by 86 respondents (26%). Smaller farm sizes of 0.5–1.0 ha were reported by 20 respondents (6%), while farms of less than 0.5 ha were rarely mentioned (1 respondent, 0.3%). Only a small proportion of providers (27 respondents, 8%) indicated that they commonly serve farms larger than 5 ha. Overall, about 85% of service providers reported that their clients typically operate on farms between 1 and 5 ha, highlighting that mechanization hire services are largely oriented toward small to medium-scale farmers and underscoring the importance of scale-appropriate and affordable mechanization solutions in the service areas.

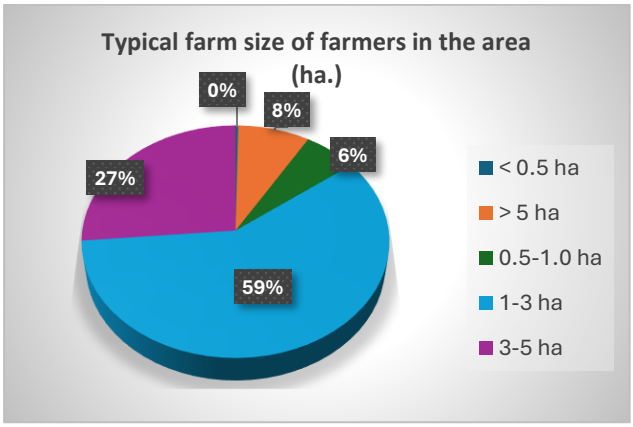

FIGURE 2 TYPICAL FARM SIZE SURVEYED AREA

Typical Topography of the Study Area

The survey area is predominantly flat, accounting for 78.46% of the landscape. This suggests favorable conditions for crop production, mechanization, and ease of farm operations.

A further 21.54% of the area is characterized by moderate topography, which may pose some limitations for bigger machines but can still be addressed with scale appropriate technologies. The dominance of flat and moderately sloping land indicates that the area is generally suitable for agricultural production, with relatively limited constraints related to terrain.

Major Soil Types in the Study Areas

In terms of soil type, the areas are predominantly characterized by loam soils, which account for 34%. These soils are generally well suited for agricultural production due to their balanced texture, good drainage, and favorable water- and nutrient-holding capacity. Silty soil is the second most common soil type, representing 30%. These soils

can support high crop productivity but may be prone to erosion if not properly managed. Light clay soil constitutes 23% of the area. While fertile, these soils may require careful management to avoid compaction and drainage-related constraints. Heavy clay soils/Vertisols account for 10%. Although typically nutrient-rich, Vertisols pose challenges such as waterlogging during the rainy season and cracking during dry periods, necessitating appropriate land and water management practices. Only a small proportion of the area is covered by sandy soil, representing 3%. These soils generally have low water- and nutrient-holding capacity and may require additional soil fertility and moisture management practices.

The dominance of loam, silty, and light clay soils indicates that the study areas are largely suitable for crop production, particularly for cereal-based farming systems, provided that soil-specific management practices are applied (Figure 3(B)).

3.4. Business Model and Organization

Ownerships

Figure 3 illustrates the distribution of ownership types in the mechanization hire service business, showing a clear dominance of the individual or private ownership model, which accounts for 83% of service providers. This indicates that mechanization services are primarily delivered through privately owned enterprises rather than collective or institutional arrangements. Farmers' Cooperative Unions represent 8% of service providers, while youth groups account for 5%, reflecting a modest but notable level of organized and group-based participation in the sector. Farmers' groups and other ownership types each contribute only 2%. Overall, this pattern suggests that private ownership remains the most viable and flexible model for mechanization service provision, while the relatively low participation of cooperatives and groups may point to challenges related to collective management and operational sustainability.

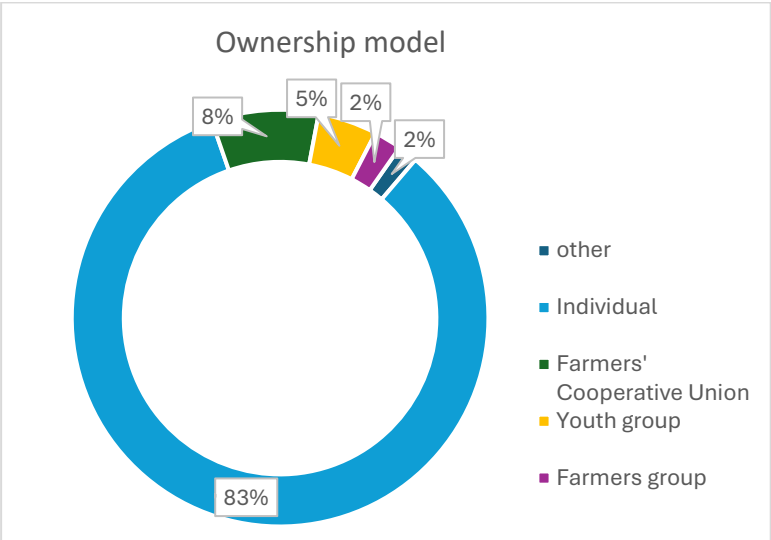

FIGURE 3 MECHANIZATION SERVICE PROVISION OWNERSHIP MODEL

Major Suppliers of Mechanization technologies

Figure 5 shows that Kegna PLC is the leading supplier of mechanization tools in the study areas, accounting for 30% of the supply. This highlights the strong role of private sector companies in providing agricultural machinery and related services. Moenco and Woreta PLC each contribute 16%, making them important secondary suppliers and indicating a relatively diversified supply base among established firms. Other multiple companies and direct import account for the remaining 38% of the supply, suggesting the presence of a range of actors.

After Sales/Mechanization Support Services

The assessment of distances between mechanization service providers and key input and support services reveals pronounced spatial disparities that significantly affect service efficiency and operating costs. Table 4 shows as service providers travel an average of 200 km to access machinery suppliers, with distances ranging from 0 to 1,075 km and a median of 164 km, indicating that most suppliers are concentrated in major towns or regional centers. This long-distance dependence increases transaction costs, transport expenses, and delays in machinery acquisition.

Access to repair services shows a mixed pattern. While basic mechanics are generally available locally—reflected by a median distance of just 1 km despite an average of 60 km—access to workshop services remain constrained. Although the average distance to workshops is 38 km, the median distance of 50 km suggests that many service providers must travel considerable distances to obtain specialized repair services, limiting timely and affordable access.

Spare parts supply is particularly centralized and distant. Service providers travel an average of 133 km to reach spare parts suppliers, with a median distance of 150 km and low variability, indicating concentration in a few fixed locations. This spatial mismatch between local repair capacity and distant critical inputs increases downtime, maintenance delays, and overall operational costs, potentially undermining the reliability and profitability of mechanization services.

Despite 68% of service providers reporting the availability of mechanization support services in their areas, a significant 32% still lack local access, highlighting persistent service gaps, especially in remote locations. Service providers are generally close to urban centers (average 7.7 km to the nearest town), and businesses are almost evenly distributed between urban (51%) and rural (49%) areas. However, providers operate over wide and highly variable geographic areas, with an average operational radius of 70.7 km and coverage extending up to 600 km, underscoring the logistical challenges and need for more decentralized mechanization support systems.

TABLE 4 DISTANCE OF SUPPORT SERVICES AND LOCATION OF THE BUSINESS

Source Distance in Km	Average	Min	Max	StD	Median
Machine suppliers	200	0	1,075	170	164
Mechanics	60	0	150	82	1
Workshops	38	1	64	33	50
Spare parts	133	64	150	38	150
Distance to the nearest town	7.7	0	80	12.25	0
Radius of operational area (km)	70.74	600	3	108.48	30
Are they available mechanization support services in your area?					
Yes (%)				No (%)	
68				32	
Where is your business located?					
Rural				Urban	
160 (49%)				166 (51%)	

Type and range of mechanization services

Figure 4 indicates that ploughing dominates mechanization service provision, with 247 service providers (76%) offering land preparation services, either as a standalone activity or in combination with other operations. Harvest and post-harvest services are the next most common, with threshing provided by 91 providers (28%) and combining by 33 providers (10%), while an additional 39 providers (12%) offer ploughing combined with threshing and 17 providers (5%) offer ploughing combined with combining, highlighting the importance of bundled service delivery. Planting services are offered by 44 providers (13%), whereas spraying, harvesting, and transportation services are each provided by about 6% of service providers. More specialized services such as winnowing (1%) and other services (2%) remain rare. Overall, the concentration of mechanization services in land preparation and selected harvest and post-harvest operations indicates an early stage of mechanization development, consistent with the literature showing that mechanization markets in Africa typically expand sequentially from primary tillage toward planting, harvesting, and post-harvest services as technical capacity and demand deepen (Diao et al., 2020).

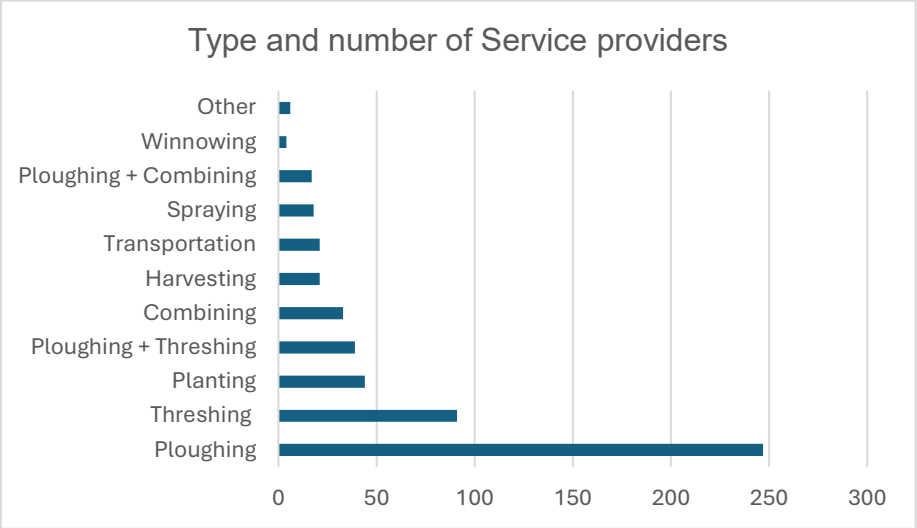

FIGURE 4 NUMBER OF SERVICE PROVIDERS PROVIDING EACH SERVICE

Business Orientation of Service Providers

Table 5 shows that the majority of respondents (76%, or 249 out of 326) are entrepreneur–farmers who use machinery primarily for hire services on a part-time basis. Full-time entrepreneurs engaged exclusively in machinery hire account for 18% (59 respondents). Only a small proportion, 6% (18 respondents), use machinery mainly for their own farm operations. Overall, the results indicate that machinery ownership is largely oriented toward service provision rather than sole use on owners' farms.

The observed business orientation strongly supports the promotion of agricultural mechanization in smallholder farming systems. In such contexts, owning machinery solely for use on one's own farm is generally neither profitable nor affordable, given the high upfront investment and low utilization rates. Consequently, the dominance of entrepreneur–farmers who both use machinery on their own farms and provide hire services to others (76%) represents an effective and practical pathway for mechanization uptake. This model allows machinery to be financially viable through shared use, while simultaneously improving access to mechanized services for smallholder farmers who cannot afford ownership. By enabling one machine to serve multiple farms, this approach accelerates the diffusion of mechanization, reduces individual investment risks, and enhances the timeliness of critical farm operations.

However, the effectiveness of this model varies by level of engagement. Full-time service providers (18%) tend to be more efficient and reliable, as they focus primarily on service provision, invest more in machine maintenance and operator skills, and are less constrained by competing demands from their own farm operations during peak seasons. In contrast, part-time providers may face limitations in service availability and consistency. Overall, while entrepreneur-led hiring models are well suited to smallholder systems, strengthening and incentivizing full-time mechanization service provision would further enhance service quality, reliability, and the overall impact of mechanization on smallholder agricultural productivity.

TABLE 5 BUSINESS ORIENTATION OF MECHANIZATION SERVICE PROVIDERS

Business Orientation	Number of respondents	Percent
Entrepreneur/farmer using machinery/s primarily for hire activities – part time	249	76%
Entrepreneur using machine only for hire activities – full time	59	18%
Farmer using machine primarily for own farm activities	18	6%
Total	326	100%

Customers and Market Segmentation

The results show that medium-scale farmers are the primary clients of mechanization service providers, accounting for 87% of the total. This highlights the strong reliance of medium-scale producers on hired mechanization services, likely due to their need to balance operational scales with limited ownership of machinery.

Large-scale farmers represent 9%, indicating a smaller but still important market segment that may require more specialized or high-capacity mechanization services. In contrast, small-scale farmers account for only 3% of the clients, suggesting limited access to or affordability of mechanization services among smallholders.

Here we found that mechanization services are predominantly oriented toward medium-scale farmers, with comparatively limited reach to small-scale producers, pointing to potential equity and access gaps in mechanization service delivery.

TABLE 6 MAIN CLIENTS

Who are your main clients?	Values
Medium Scale	284 (87%)
Large Scale	28 (9%)
Small Scale	11 (3%)
Others	3 (1%)

Customer Size and Operation Radius

The table (7) presents summary statistics on the scale of service delivery by mechanization service providers, measured by the number of farmers served and the operational radius. On average, a service provider serves 774 farmers, with the number ranging from as few as 15 to as many as 23,640, indicating substantial variation in business scale. The median of 240 farmers suggests that more than half of service providers operate at a relatively small scale, while a limited number of large providers (e.g. Farmers' Cooperative Unions) serve exceptionally high numbers of farmers, as reflected in the high standard deviation (1,885).

Similarly, the average operational radius is 71 km, with service areas ranging from 3 km to 600 km. The median radius of 30 km indicates that most service providers operate within localized markets, while a small proportion cover very large distances. The wide variation (standard deviation of 108 km) reflects differences in mobility, equipment capacity and the spatial distribution of demand.

TABLE 7 CUSTOMER SIZE AND OPERATION RADIUS

Customer size and operation radius	Average	Min	Max	StD	Median
Number of farmers served	774	15	23,640	1885	240
Operation radius	71	3	600	108	30

Proportion of Female client

The share of female-headed household clients averages 11% but varies considerably across businesses (from 0% to 50%). The low median of 10% indicates that most service providers serve a relatively small proportion of female-headed households, pointing to gender-related access gaps in mechanization services. Women's lower representation among service clients further reflects structural inequalities in land ownership, decision-making power, and access to productive resources, which limit their ability to demand mechanization services even when benefits are substantial (Doss et al., 2020).

TABLE 8 PROPORTION OF FEMALE HEADED HOUSEHOLD CLIENTS

Client category	Average	Min	Max	StD	Median
Female headed household clients (%)	11	0	50	9	10

Evidence from gender-responsive mechanization programs suggests that targeted finance, women-focused technical training, and mentorship can significantly increase women's participation along mechanization value chains, transforming mechanization into a pathway for economic empowerment rather than solely a labor-saving intervention (Doss et al., 2020; FAO, 2022).

Employment Opportunity and Working Capital

Mechanization creates employment opportunities by generating demand for machine operators and support staff in rural areas. On average, each mechanization service provider employs about 4 workers, although the median and mode of 2 employees indicate that most providers operate with small teams. The highly skewed distribution and wide range of employment show that a few providers hire a much larger workforce, which raises the overall average. In particular, farmers' cooperatives employ more (on average 10) labor than individual service providers, thereby increasing the mean number of employees and highlighting the stronger employment-generation potential of cooperative-based mechanization models. In addition, the data indicates that about 35% of service providers rely on household labor for their hire service operations, with an average of 1.5 unpaid household members involved per business. This underscores the role of mechanization not only in creating hired employment but also in generating family-based livelihood opportunities and diversifying household income sources within smallholder farming systems. Regarding financial capacity, the average working capital is ETB 17.1 million, with a minimum of ETB 550,000 and a maximum of ETB 350 million. The median working capital of ETB 8 million, together with a very high standard deviation (ETB 32.5 million), highlights large disparities in financial strength among service providers, with most operating at relatively modest capital levels and a few highly capitalized businesses skewing the average.

TABLE 9 EMPLOYMENT AND WORKING CAPITALS

Employment	Average	Min	Max	StD	Median
Number of employments	4	1	86	7	2
unpaid family member	1	0	4	0.82	1
Working capital	17,091,340	550,000	350,000,000	32,456,668	8,000,000

Key partners

Nearly half of the respondents (44%, representing 142 businesses) reported a high level of dependence on partner support and activities, while an additional 39% (129 businesses) indicated a medium level of dependence, demonstrating that more than four-fifths (83%) of mechanization service providers rely on partners for their business operations. This strong reliance confirms that mechanization service provision is not solely a technology-driven activity but a system dependent on a broad network of interdependent partners. Survey results further support this view, with service providers most frequently identifying repair and maintenance services (137 mentions) as critical partners, underscoring the central importance of machine uptime and technical support. This is followed by suppliers (64) and financial institutions (62), highlighting the role of reliable input supply and access to finance in sustaining

operations. The involvement of brokers (48) and public institutions (42) further reflects the importance of coordination, market linkage, and an enabling policy environment. Collectively, these findings demonstrate that effective mechanization service delivery depends not only on machinery, but also on the performance and coordination of multiple partners across the service value chain.

TABLE 10 KEY PARTNERS

Key partners	Frequency
Public institutions	42
Brokers	48
Farmers' cooperative	3
Farmers	3
Financial institutions	62
NGOs	16
Repair and maintenance	137
Suppliers	64
Fuel stations	3
Insurance companies	1

Type and number of mechanization technologies owned

Table X summarizes the total number of agricultural machines owned by the 326 mechanization service providers interviewed. The results show a strong dominance of four-wheel tractors, with a total of 298 units, confirming their central role in mechanized service provision. Ownership of primary tillage implements is also high, particularly disc ploughs (277 units) and moldboard ploughs (110 units), indicating that land preparation is the most common mechanization service offered.

Post-harvest and harvesting equipment are moderately represented. The survey recorded 79 threshers and 75 combine harvesters, suggesting a growing but still limited capacity for mechanized harvesting and post-harvest operations. In contrast, ownership of harvesters/reapers remains very low (7 units), pointing to continued reliance on combines or manual methods for harvesting in many areas.

Other supporting and specialized equipment are scarce among service providers. These include seeders/planters (7 units), trailers (4 units), and winnowers (4 units). Sprayers (19 units) are slightly more common but still limited in number. Additionally, ownership of two-wheel tractors is minimal (5 units), reflecting their limited use in the surveyed regions.

Overall, the distribution of machinery ownership highlights a mechanization system heavily focused on tractor-based land preparation, with comparatively low investment in planting, transport and post-harvest equipment, indicating potential gaps and opportunities for diversification of mechanization services.

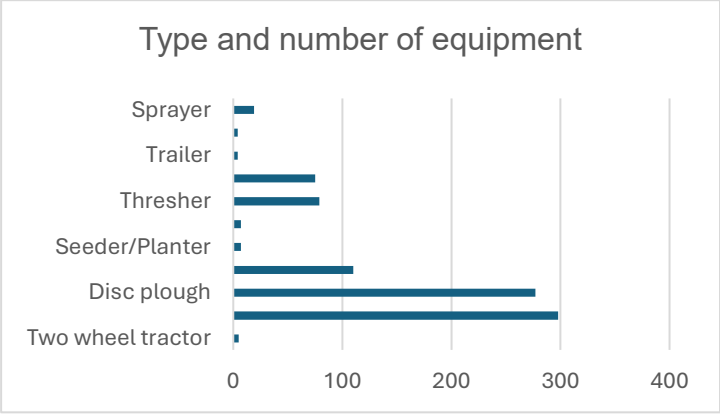

FIGURE 5 TYPES OF MECHANIZATION TECHNOLOGIES AND IMPLEMENTS

Acquisition of Technologies and Access to Finance

The survey results highlight the critical role of finance and public support mechanisms in agricultural mechanization development. Among the 326 mechanization service providers surveyed, 57% (187) acquired machinery using their own funds, reflecting strong private-sector initiative but also indicating the high upfront investment costs that limit faster and more inclusive mechanization uptake. Access to formal bank financing, reported by 67% (217) of respondents, suggests growing recognition of mechanization as a bankable investment; however, 17% (56) relied on project- or government-supported financing, pointing to persistent gaps in inclusive financial services, particularly for emerging service providers. In addition, only 18% (58) of respondents reported purchasing subsidized machinery, indicating that subsidy programs remain limited in coverage. While subsidies can play a catalytic role in lowering entry barriers and accelerating technology adoption, the findings suggest that mechanization growth is still largely driven by private investment rather than public support. Strengthening tailored financial products, risk-sharing mechanisms, and well-targeted smart subsidies will therefore be essential to crowd in private capital, enhance equity in access to mechanization services, and ensure sustainable sector growth.

TABLE 11 MECHANIZATION TECHNOLOGY ACQUISITION AND SUBSIDY STATUS

Technology acquisition methods	Number of Service providers	Percentage
Through projects and government support	56	17%
Privately/direct purchase	186	57%
Bank credit	217	67%
Was any of the equipment subsidized?		
Yes (%)	No (%)	
58(18%)	82%)	

Flow of services

The survey results indicate that 75% (245) of mechanization service providers rely on intermediaries to facilitate the delivery and coordination of their services. Among those using intermediaries, an overwhelming 92% (225) depend on local brokers, while only 8% (19) reported using digital service platforms, highlighting the continued dominance of informal, location-based market linkages. The data further show that the average commission paid to intermediaries is 4%, with a median of 2%, suggesting that while most transactions involve relatively low commissions, a small number of cases face substantially higher charges, as reflected by the maximum commission rate of 30% and a standard deviation of 4%.

This pattern indicates that mechanization service markets are still largely broker-driven and informal, with limited penetration of digital coordination mechanisms that could improve transparency, reduce transaction costs, and expand market reach. The wide variation in commission rates also points to information asymmetries and uneven bargaining power, particularly affecting smaller or less established service providers. Strengthening digital matchmaking platforms, transparent pricing mechanisms, and organized service provider networks could reduce dependency on intermediaries, improve service efficiency, and enhance profitability, thereby supporting more inclusive and scalable mechanization service delivery.

TABLE 12 FLOW OF MECHANIZATION SERVICES

Commission	Average	Min	Max	StD	Median
Percent of commission	4	1	30	4	2
Are there intermediaries in the flow of services (e.g. brokers, sales agents etc.)?					

Yes (%)	No (%)
245 (75%)	81 (25%)
Who are the intermediaries	
Local brokers	Digital services
225 (92%)	19 (8%)

Value proposition

Compared to other service providers, 90% of respondents identified quality of work as the primary factor distinguishing their services from others offering similar operations. Timeliness of service delivery and customer trust were each cited by 71% and 70% of respondents respectively, underscoring the importance of reliability and reputation in mechanization service markets. In contrast, only 42% and 27% of respondents indicated that the provision of credit services and lower service charges, respectively, differentiate their services from competitors.

These findings suggest that competition among mechanization service providers is driven more by service performance and relational factors than by price-based strategies. This indicates a maturing service market in which farmers increasingly value quality, punctuality, and trust over cost reductions alone. At the same time, the relatively low emphasis on credit provision and pricing highlights potential gaps in integrated service offerings, suggesting opportunities for bundled services, innovative financing models, and customer-oriented business development support to further strengthen competitiveness and inclusiveness in mechanization service delivery.

TABLE 13 WHAT MAKES YOUR SERVICE UNIQUE AND DIFFERENT FROM OTHERS PROVIDING SIMILAR SERVICES

Quality of work	Timeliness of operations	Low charges/price	Credit	Trust by customers	Other
292	232	90	137	228	9
90%	71%	28%	42%	70%	3%
Does the service solve a need that the farmer can't fill elsewhere?					
Yes (%)				No (%)	
226 (69%)				100 (31%)	

Table 13 also indicates that a substantial majority of mechanization service providers—69% (226 respondents)—reported that their services address needs that farmers cannot easily meet through alternative means. This finding underscores the critical role of mechanization services in filling labor, timeliness, and capacity gaps within smallholder farming systems. Conversely, 31% (100 respondents) indicated that their services do not address unique needs, suggesting that in some areas mechanization services may overlap with existing conventional farming systems or face competition from alternative service arrangements.

Among the various challenges faced by farmers, 77% of service providers reported that their services help address quality-related problems associated with conventional farming practices. This was followed by reductions in time requirements (76%), labor shortages (56%), and high drudgery (52%). In addition, 37% of respondents indicated that their services help reduce the cost of production, while 28% reported that they help mitigate shortages of draft animals.

TABLE 14 MAJOR FARMERS PROBLEMS ADDRESSED BY MECHANIZATION

Which of the customers' problems is the business helping to solve?						
Problem related to drudgery	Higher cost of conventional operational system	Time taking conventional farming system	Quality of operation	Shortage of labor	Shortage of drought animal	Other
170	121	249	252	182	90	7
52%	37%	76%	77%	56%	28%	2%

Constraints on the utilization and access to repairs and maintenance

Machinery breakdowns and frequent wear of implement parts were identified as major operational constraints faced by mechanization service providers. About 80% of service providers (261 respondents) reported experiencing at least one machinery breakdown during the past 12 months, with an average repair time of 18 days, ranging from as short as 1 day to as long as 210 days. Such prolonged downtime significantly disrupts service delivery, particularly during peak agricultural seasons when delays can lead to missed planting or harvesting windows.

TABLE 15 AVERAGE DOWNTIME PERIOD OF MECHANIZATION TECHNOLOGIES

Downtime	Average	Min	Max	StD	Median
No of days	18	1	210	26	10
Have you had any machinery problems/ breakdowns over the last year?					
Yes (%)				No (%)	
261 (80%)				65 (20%)	

In addition to mechanical failures, limited access to fuel and spare parts was cited as a major constraint by 89% (290 respondents) and 83% (270 respondents) of service providers, respectively. Together, these constraints highlight systemic challenges in the mechanization ecosystem, including weak supply chains, limited local repair services, and inadequate after-sales support, which undermine the reliability and efficiency of mechanization services.

TABLE 16 MAJOR OPERATIONAL CONSTRAINTS

Unsuitability of the machine	Uncertain customer demand	Shortage of operators	Poorly skilled operators	Difficulty moving from client to client	Difficulty getting fuel/ oil	Difficulty accessing spare parts	Infrastructure problem (road etc.)	other
46	24	53	78	80	290	270	70	53
14%	7%	16%	24%	25%	89%	83%	21%	16%

Service efficiency

The efficiency indicators show substantial variation in the time required to complete mechanized field operations. On average, ploughing one hectare of land takes 1.6 hours, with a median of 1.5 hours, indicating that most service providers operate close to the average performance level. However, the wide range—from as low as 0.5 hours to as high as 12 hours per hectare—together with a relatively high standard deviation (0.93) reveals significant disparities in operational efficiency. A key factor driving this variation is tractor size and power: the highest time requirement (12 hours per hectare) is associated with two-wheel tractors, which have limited working width and

lower field capacity, while the lowest values (around 0.5 hours per hectare) correspond to larger, high-horsepower tractors operating wider implements at higher field efficiency. Additional factors such as implement type and condition, soil characteristics, field size and shape, operator skill, and the frequency of machinery breakdowns further contribute to these differences.

In contrast, combining operations exhibit higher and more consistent efficiency. On average, combining one hectare requires 0.78 hours, with a median of 0.5 hours, indicating a lower time requirement compared to ploughing. The narrower range (0.25 to 2 hours per hectare) and lower standard deviation (0.47) suggest more uniform performance across service providers. This consistency likely reflects more standardized combine harvester technology, greater operator specialization, and more uniform field conditions during harvesting operations.

TABLE 17 EFFICIENCY OF SERVICE PROVISION FOR SELECTED TECHNOLOGIES

Efficiency	Average	Min	Max	StD	Median
# of hours takes to plough a hectare of land	1.6	0.5	12	0.93	1.5
# of hours takes to combine a hectare of land	0.78	0.25	2	0.47	0.5

Potential vs actual performance

The results reveal a consistent gap between the potential operational window and the actual number of days services were provided, for both ploughing and combining operations.

For ploughing services, service providers reported an average annual potential operation window of about 117 days (median 120 days), reflecting periods when field and weather conditions are suitable for ploughing. However, the actual number of days ploughing services were delivered averaged about 85 days, indicating that service providers utilize only around 73% of their potential ploughing window. This gap suggests that, despite favorable conditions, service provision is constrained by factors such as machinery breakdowns, limited availability of spare parts, overlapping demand peaks, operator fatigue, fuel shortages, or financial and logistical challenges. The wide range in actual service days (15 to 260 days) further highlights heterogeneity among service providers, likely reflecting differences in machinery type, business scale, and geographic coverage.

A similar but slightly narrower gap is observed for combining services. The average potential operation window for combining is approximately 108 days (median 120 days), while service providers reported delivering services for an average of 92 days (median 90 days). This indicates that about 85% of the potential combining window is utilized, suggesting more efficient use of available time compared to ploughing operations. The relatively higher utilization rate and narrower gap may be attributed to the time-sensitive nature of harvesting, stronger demand concentration, and more reliable performance of combine harvesters, as previously reflected by their higher and more consistent operational efficiency.

Overall, the results indicate that while mechanization service providers operate within reasonably long seasonal windows, a substantial share of potential service days remains unused, particularly for ploughing. Closing this gap would require addressing operational bottlenecks such as machinery reliability, preventive maintenance, access to skilled operators, and better scheduling and coordination of services. Improving utilization of the available operational window could significantly enhance service providers' incomes and improve the timeliness of mechanized services for farmers.

TABLE 18 POTENTIAL VS ACTUAL OPERATION WINDOW

Potential window vs actual number of operations	Average	Min	Max	StD	Median
Annual Potential operation window of ploughing service (# of days)	117	30	270	49	120
Actual number of days you provided ploughing service over the last 12 months	85	15	260	0	0.5
Annual Potential operation window of combining service (# of days)	108	60	150	4	120
Actual number of days you provided combining service over the last 12 months	92	30	150	26	90

Hire charge and Revenue

The results indicate substantial variation in hire charges, pricing strategies, and annual revenues among mechanization service providers, reflecting differences in machinery type, scale of operation and market reach.

On average, the ploughing hire charge is ETB 8,079 per hectare, with a median of ETB 8,000, suggesting relatively standardized pricing across different regions and service providers. However, the observed range—from ETB 4,800 (for two-wheel tractors) to ETB 12,500 per hectare—and a standard deviation of ETB 1,549 indicate meaningful price dispersion. This variation likely reflects differences in tractor size and horsepower, fuel costs, field conditions, distance traveled to service sites, and local market competition.

Similarly, the average combining hire charge is ETB 8,569 per hectare, with a median of ETB 8,000. The narrower range (ETB 6,000 to ETB 12,000) and comparable standard deviation (ETB 1,726) suggest somewhat greater price consistency for combining services than ploughing. This is likely due to most of the combiner owners are from similar geographic areas, i.e. Arsi, West Arsi and Bale zones of Oromia region.

Service providers reported an average markup of 36% across all services, with a median of 30%, indicating moderate profit margins. However, the wide range (10% to 75%) highlights significant differences in business efficiency and cost control. Higher markups may be achieved by providers operating in relatively lower market competition area, with larger machinery fleets, better utilization rates, or lower maintenance and fuel costs, while lower markups likely reflect high operating expenses, frequent machinery breakdowns, and or competitive pricing pressures.

In terms of business performance, annual estimated revenue from ploughing averages ETB 2.69 million, but with a very wide range (ETB 50,000 to ETB 30.6 million) and high variability. This indicates strong heterogeneity in scale, with many small operators coexisting alongside a few large service providers (farmers' cooperative union and bigger individual SPs-with larger machinery fleet) operating across extensive geographic areas. Revenue from combining is substantially higher, averaging ETB 13.5 million annually, with a median of ETB 6.18 million and a maximum reaching ETB 140 million for cooperative unions providing service with multiple combiners.

Overall, the findings suggest that while mechanization services can be financially attractive returns are highly uneven across providers. Improving machinery reliability, increasing utilization of the operational window, and supporting efficient business management practices could help smaller and medium-scale service providers enhance profitability and sustainability.

Pricing strategies

Figure 6 show that mechanization service providers use multiple approaches to set hire charges, reflecting varying levels of business planning and market orientation. The most commonly reported method is calculating operating costs and adding a markup, used by 37% of service providers, indicating that over one-third apply a cost-based pricing strategy. This suggests a growing awareness of the need to recover expenses such as fuel, labor, maintenance, and depreciation while ensuring profitability.

At the same time, a substantial proportion of providers rely on market-based pricing mechanisms. About 31% set prices based on existing market rates, while 28% determine their hire charges by comparing with other service providers. Together, these approaches account for nearly 60% of respondents, highlighting that pricing decisions are strongly influenced by local competition and prevailing market conditions rather than detailed cost-based accounting. This reliance on external benchmarks may help providers remain competitive but also exposes them to the risk of underpricing if actual operating costs are not fully considered. Similar patterns have been documented in mechanization studies across Africa, where service markets are notably competitive but characterized by fragmented operators with limited pricing strategies (Van Loon et al., 2020).

Overall, the findings indicate that while cost-based pricing is the single most common approach, the majority of service providers do not systematically calculate full operating costs when setting hire charges. Strengthening

business and financial management skills—particularly in cost calculation and pricing strategies—could improve profitability, sustainability, and investment decisions within the mechanization service sector.

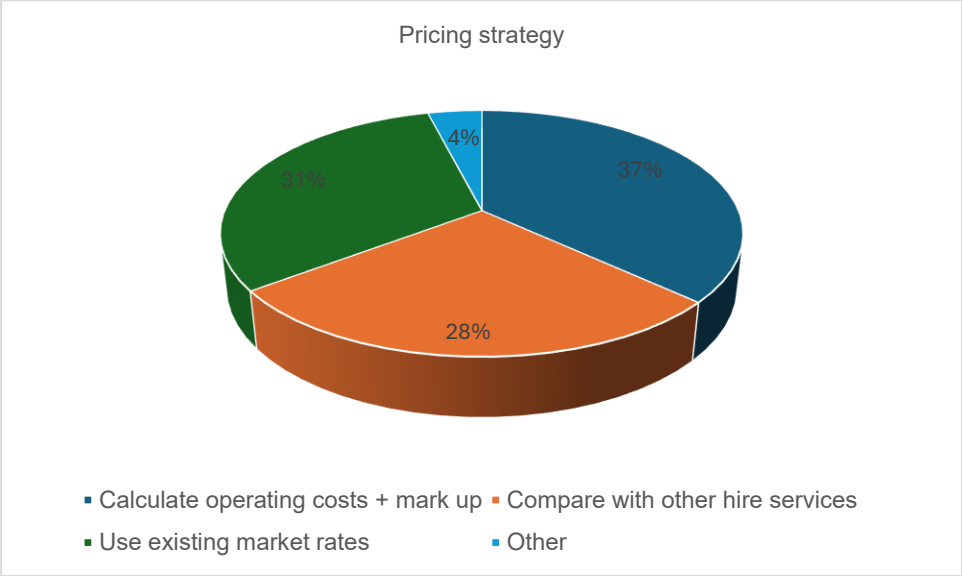

FIGURE 6 PRICING METHODS OF MECHANIZATION SERVICE PROVIDERS

Number of famers made use of different mechanization technologies

The results indicate substantial variation in the number of farmers reached annually by mechanization service providers across different types of services and service provision models reflecting differences in service capacity, demand patterns, and operational efficiency.

On average, a service provider serves 454 farmers per year for ploughing services, with a median of 225 farmers, indicating that while a few large providers serve very high numbers of farmers (up to 5,000), most providers operate at a much smaller scale. The high standard deviation (685) further underscores the wide disparity in outreach, which is closely linked to differences in tractor size, operational efficiency, geographic coverage, and the length of the service provision window.

For planting services, the average number of farmers served per year is 85, with a median of 126. The relatively lower average and narrower range (5 to 800 farmers) suggest that planting mechanization is less widely adopted and often provided on a more limited scale. This may reflect lower availability of suitable planters, crop specificity, or farmers' preference for traditional planting methods in some areas.

In the case of threshing and shelling services, service providers serve an average of 354 farmers per year, with a median of 100 farmers. The wide range (5 to 2,500 farmers) and high variability indicate mixed levels of mechanization uptake, likely influenced by crop type, seasonal labor availability, and the portability and affordability of threshing equipment.

By contrast, combining services reach the largest number of farmers, with an average of 1,793 farmers per provider per year and a median of 940 farmers, and some providers serving up to 10,000 farmers annually. This reflects the high efficiency and capacity of combine harvesters, their ability to operate continuously during short harvesting windows, and strong farmer demand for timely harvesting services to minimize crop losses.

Overall, the findings highlight that mechanization service providers have very different scales of operation, with combining services demonstrating the greatest outreach per provider. Expanding access to planting and threshing services, and improving efficiency and coordination in ploughing services, could significantly increase the number of farmers benefiting from mechanization, particularly among smallholder farmers.

Mechanization marker competition

The findings indicate that mechanization service markets are highly competitive in most surveyed areas. About 66% of service providers reported facing more than 10 competitors, while an additional 22% indicated the presence of 5 to 10 competitors in their operational area. Only 10% reported fewer than five competitors, and a very small share (2%) indicated having no competitors at all. This suggests that mechanization services are widely supplied and that most providers operate in crowded and competitive local markets.

In terms of competitive strength, the majority of respondents perceive their competitors as strong or very strong. Specifically, 64% rated competitors as strong, and 26% described them as very strong, while only 10% considered competitors to be weak or very weak. This perception reflects intense rivalry, likely driven by similar service offerings, limited differentiation, and strong price competition, particularly during peak agricultural seasons.

Regarding the geographic origin of competitors, competition is not confined to immediate localities. While 29% of competitors operate within the same village, a larger share come from outside the village but within the district (36%) or outside the district but within the same region (31%). Only 4% of competitors originate from outside the region, indicating that competition is primarily regional rather than national. This mobility of service providers, especially during peak demand periods, contributes to market integration but also intensifies competition in high-demand areas.

Finally, the results show that competition is overwhelmingly driven by individual mechanization service providers, who account for 96% (314 respondents) of competitors, with only 4% (12 respondents) representing other organizational forms such as cooperatives or group-based enterprises. This dominance of individual operators highlights the fragmented nature of the mechanization service market and suggests limited collective action or consolidation among providers.

Overall, the findings indicate a highly competitive and fragmented mechanization service environment, characterized by strong rivals, mobile service providers, and limited differentiation. While competition can benefit farmers through lower prices and improved access, it may also constrain profitability for service providers, underscoring the importance of efficiency improvements, service diversification, and business management support to ensure long-term sustainability.

TABLE 19 MARKET COMPETITION

How many competitors are there in your area?			
Between 5 and 10	Greater than 10	Less than 5	No competitors
22%	66%	10%	2%
How strong are they?			
Strong	Very strong	very weak	weak
64%	26%	2%	8%
In general, where do they come from?			
Out of the region	Outside the district but within the region	Outside the village but within the district	Within the village
4%	31%	36%	29%
Who are they?			
96% (314) Individual mechanization service providers		4% (12) others	

3.5. Enabling Environment

The results indicate that mechanization service providers generally perceive the current enabling environment as moderately conducive, though not strongly supportive of business growth. On a four-point scale (1 = low, 4 = high), the majority of respondents rated the enabling environment at medium levels. Specifically, 57% of service providers (186 respondents) assigned a score of 3, while 36% (117 respondents) rated it as 2. Together, these results show that nearly 93% of respondents perceive the enabling environment as neither highly favorable nor highly restrictive but rather as moderately supportive.

Only a small proportion of service providers expressed strong confidence in the enabling environment, with just 5% (15 respondents) assigning the highest score (4). Conversely, a very limited share—2% (8 respondents)—rated the environment as poor (score 1), indicating that severe constraints are not widespread but do exist for a minority of providers.

Overall, these findings suggest that while the enabling environment allows mechanization service businesses to operate, significant structural and institutional constraints remain that prevent many providers from fully realizing their business potential. Improving access to finance, strengthening after-sales and maintenance services, enhancing policy clarity, and improving infrastructure could help shift perceptions toward a more favorable enabling environment and support the sustainable growth of mechanization services.

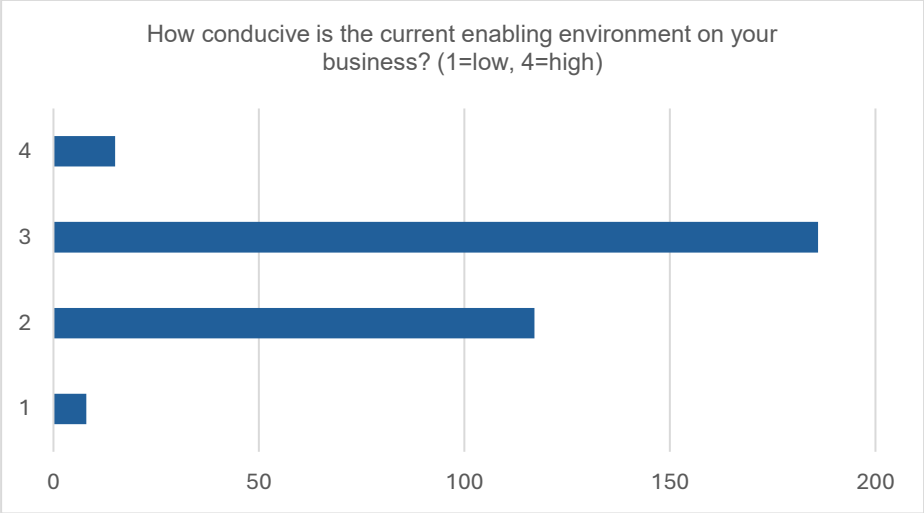

FIGURE 7 ENABLING ENVIRONMENT

4. Conclusion

The findings of this study demonstrate that the existence of different mechanization hire service provision models in Ethiopia's providing services mainly targeting semi-commercial smallholder farmers operating on 1–5 ha of land. The dominance of private ownership, the concentration of services in land preparation, and the strong presence of experienced providers indicate a sector that is functional and demand-driven, yet still at an early stage of diversification and inclusivity.

The analysis highlights clear structural and systemic challenges. Limited regional coverage, minimal participation of women as service providers and service user, slowing entry of new businesses, and persistent operational constraints—such as machinery breakdowns and weak spare-parts and fuel supply chains—continue to restrict the growth and effectiveness of mechanization services. These challenges are compounded by rising equipment costs and security problems in some area, which raise financial risks for service providers and discourage new entrants.

Overall, the evidence suggests that future efforts to strengthen mechanization in Ethiopia should move beyond increasing machinery numbers alone. Policy and development interventions should focus on improving after-sales services, fuel supply chains, expanding access to affordable finance, and supporting gradual service diversification beyond primary tillage and threshing/combining. Targeted measures are also needed to promote gender-inclusive participation and to extend mechanization services to underserved regions and smaller-scale farmers. Addressing these issues will be critical for ensuring that mechanization hire services are inclusive, efficient, sustainable, profitable and affordable for smallholder farmers.

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