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The Operational Impediments of County Agricultural Mechanization Services in Kenya

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Abstract

This study was motivated by the critical role of well-managed tractor hire services in advancing food self-sufficiency and nutrition. The primary goal was to identify the factors hindering the efficient operation and success of the County-operated Agricultural Mechanization Service (AMS) in Kenya, specifically in serving small-scale farmers.

A conditional survey technique using mixed question types was employed to collect data from 37 of Kenya's 47 counties. The data was subsequently analyzed using descriptive statistics.

The analysis highlighted several significant challenges for establishing a functional Tractor Hire Service. About 55% of the workforce was heavily skewed toward plant operators and 59% of AMSs lacked a dedicated service shop. Over 40% of AMSs park equipment during off-season periods. Breakdowns consumed 25% of the operational time. The supply procedure delays accounted for 18%, and late fuel deliveries accounted for 16% of the time. County administration interference was cited by 20% of respondents. Stiff competition from private tractor hire schemes stood at 6%, with expectations to rise. The major services provided were ploughing, harrowing, and transportation, yet the lack of post-harvest handling services is significant, as this area is responsible for over 30% of food losses.

Based on these findings, the paper strongly recommended several actions to improve AMS functionality and success: Prioritize employing relevant qualified staff and conducting routine on-the-job training, install modern technology, including GPS for acreage estimation, tractor trackers for real-time location, mileage, ploughed area, and fuel consumption monitoring, Acquire tractor models with reliable back-up/ after-sales service available locally, Establish an operational service shop, Run the service professionally as a business, Match machine units to the projected workload to optimize labor efficiency.
(Note: Visual evidence of the fleets, Plates 1-28 and Table 1, was included in the original study.)

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History and Evolution of Agricultural Mechanization in Kenya

Agricultural mechanization services in Kenya began in 1947 with the establishment of the Soil Conservation Services (SCS), which utilized heavy earth-moving equipment (the Plant Hire Service - PHS) primarily for land opening in the former white highlands and for constructing soil conservation and water harvesting structures. This effort aimed to increase land under agricultural production.

In 1965, the government introduced the Tractor Hire Service (THS). Its goals were to facilitate new land cultivation (especially for wheat), promote modern farming techniques, encourage private ownership of machinery, and train farmers in proper seedbed preparation.

The Agricultural Mechanization Services (AMS) was officially formed in 1981 through the merger of the THS and PHS. Later, in the late 1970s and early 1980s, a rural technology promotion department was created within the Ministry of Agriculture to champion appropriate technologies in agricultural implements, rural energy, and industry, which later expanded through four AMS rural technology promotion centers.

Current Status and Study Rationale

The original objective of public tractor hire services was to provide farmers, who could not afford to own machinery, with access to equipment at subsidized rates. Today, following the 2010 constitutional devolution of agriculture, several County Governments operate AMS Stations, offering a range of services from land preparation and planting to harvesting and post-harvest handling. These services are still categorized as PHS (for crawlers) and THS (for wheeled tractors). Despite these long-standing efforts, the predominant opinion is that Public Hire Schemes have, in general, been unsuccessful.

The Problem and Study Objectives

The inherent challenges of mechanization in Kenya are compounded by the country's wide agro-ecological amplitude and the expansion of services into more arid regions, where viability is questionable due to unpredictable rainfall.

This study seeks to establish the likely causes of failure experienced in Public Hire Services by collecting and summarizing relevant data. The overall aim is to develop hypotheses for the successes and failures of these schemes and determine what crucial lessons can be learnt.

Specifically, the study will address the following core questions:

1. Are Tractor Hire Schemes intrinsically doomed to failure?
2. Under what conditions do they have a chance of success, and how appropriate are they to the agricultural problems faced by counties?

Contextual Trends in Mechanization

By 2012, 78 plants and 115 tractors were available across 24 AMS stations supplied by the national government. The demand for mechanization is rising, driven by increasing population, greater food demand, and the need to overcome critical labour bottlenecks (especially during land preparation) created by urbanization and changing farming systems. Furthermore, young farmers are increasingly demanding mechanization to avoid the drudgery associated with manual agricultural work.

Historical failures in African mechanization programs (Kenya, Nigeria, Tanzania, etc.) have often been attributed to governance challenges (e.g., rent-seeking) and a lack of access to spare parts, qualified operators, and technicians. However, scholars note that improved market access and urban population growth have created a more elastic demand for agricultural products today, suggesting that mechanization could now lead to an expansion of agricultural area, output, and

employment, especially with the rise of medium-scale farmers.

Methodology and Conceptual Framework

The underlying motivation for this study stems from the alarming sight of relatively new, dilapidated farm equipment in junkyards across Kenyan counties. These machines are often stripped of valuable auxiliary components, such as front ballast weights and electrical parts (battery, starter, alternator). This issue highlights a significant inefficiency in a sector crucial for Kenya's economic growth and food security.

This research posits that improving agricultural productivity through efficient mechanization is vital for Kenya to reduce food deficits and potentially increase exports. Historically, Kenya was a net wheat exporter between 1944 and 1952 (Chadwick et al., 2016), supporting a population of approximately 6 million (UN Population). Following Boserup's (1965) principle that intensification of agriculture is driven by increasing population, modern Kenya, with its population of 54 million, should be capable of producing even more food.

Sampling and Data Collection

Sampling Strategy

The study employed a Cluster Sampling method.

- Clusters were defined as the Counties.
- The target population consisted of individuals who were county members or residents and were stakeholders or interested parties in agricultural mechanization within their respective counties.

Data Collection Process

Information was collected from what was initially intended to be a sample of agricultural mechanization hire schemes across 37 counties in Kenya.

1. An interactive electronic questionnaire was developed and shared (URL).
2. Respondents were asked to snowball (share) the questionnaire with relevant peers in their or other counties.
3. A combination of data collection methods was used: telephone surveys, face-to-face surveys, and online surveys.
4. Data from 37 county hire schemes were ultimately gathered, exceeding the planned critical number of 16, at which point data collection was halted.
5. Verification of evidence involved site visits to some counties and utilizing proxies in others.
6. All collected data were standardized and converted into the "Survey-nut" format (refer to Appendix 2 for the questionnaire). The list of responding counties is detailed in Appendix 1.

Data Analysis, Results, and Discussion

County Response and Existing Agricultural Mechanization Service (AMS) Centers

Of the 47 counties 37, responded to the questionnaire (see Annex 1). Of the responding counties, 68% reported having pre-existing Agricultural Mechanization Service (AMS) centers before the 2010 constitution was enacted, which fully devolved the Ministry of Agriculture and related functions (as illustrated in Figure 1).

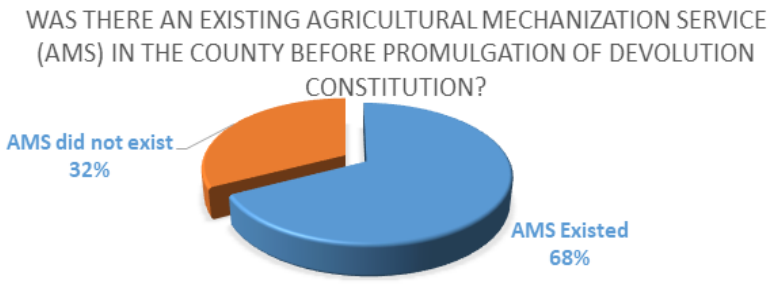

Figure 1: AMS situation before promulgation of the 2010

Implications of the 2010 Constitution on AMS Centers

The promulgation of the 2010 Constitution completely devolved the Ministry of Agriculture and related functions, fundamentally changing the operational context for Agricultural Mechanization Service (AMS) centers.

Functional Transfer to Counties

- Devolved Function: Agricultural services, including crop and animal husbandry and implicitly Agricultural Mechanization Services (AMS), were transferred from the National Government to the 47 County Governments (as outlined in the Fourth Schedule of the Constitution).
- New Management: The existing AMS centers, which were previously national entities, came under the direct management and oversight of their respective County Governments. Counties are now responsible for establishing, funding, regulating, and operating these services.

Operational Challenges and Opportunities

This shift created both opportunities and significant challenges for the centers:

Aspect	Pre-2010 (National Government)	Post-2010 (County Government)
Funding	Centralized allocation, often perceived as a 'top-down' system.	Funding is derived from county-level budgets and shared national revenue. This can lead to inadequate or irregular funding depending on the county's fiscal capacity and priorities.
Machinery	National government supplied equipment to AMS stations (e.g., 115 farm tractors across 24 stations by 2012).	Individual County Governments are now responsible for acquiring and maintaining their own fleet of tractors and equipment, leading to variations in service quality.
Focus	Often national or large-scale farming oriented (like the original Tractor Hire Service).	Increased opportunity for localization and tailoring services to the specific needs of small-scale farmers within the county.
Governance	Centralized bureaucracy.	Risk of governance challenges (e.g., political interference, lack of technical capacity) at the county level, which can affect the efficiency of service delivery.
Legal Framework	Governed by national laws.	Counties are enacting specific county legislation (like the Lamu County AMS Bill) to govern their mechanization services, creating a diverse regulatory landscape.

In essence, the move brought the services closer to the people, aligning with the objectives of devolution, but simultaneously presented resource and capacity issues as county governments had to absorb and manage complex technical operations like AMS.

AMS Centre Implementation Post-2010 Constitution

Of the 47 counties that did not have an Agricultural Mechanization Service (AMS) before the 2010 Constitution, 32% have since established Centres. Implementation was phased: 50% began in the first term, 17% in the second, and 8% in the third. A quarter of these counties (25%) reported that they do not require the service (Figure 2).

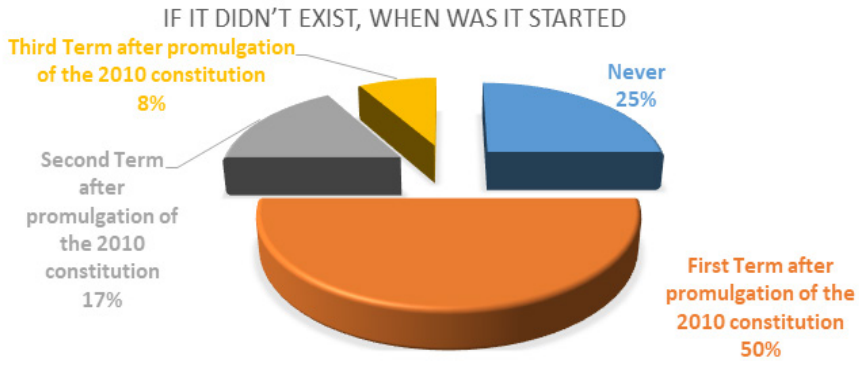

Figure 2: Show percentage of counties that started AMS after promulgation of the 2010 constitution

The three counties without an AMS are Nairobi, Mombasa, and Kirinyaga. Nairobi and Mombasa are highly urbanized. In Kirinyaga, despite its agricultural activity (primarily perennial crops), the service is deemed unnecessary due to the high availability of private tractor hire services within the Mwea Irrigation Scheme, which offers land preparation and baling tractors, and crawler combine harvesters. A review of the AMS centers revealed the following most common tractor makes: Case International (33%), Massey Ferguson (26%), New Holland (15%), John Deere (11%), and Kubota (4%). Unspecified models accounted for 11%.

Tractor Makes and Agricultural Management Service (AMS) Centers:

Case International and Massey Ferguson were the top two makes acquired by County

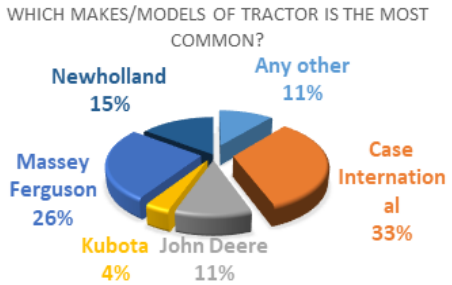

Figure 3: Common Tractor makes at County AMS centres

Governments. The popularity of these brands is generally attributed to three main factors: extensive geographical after-sales service, high levels of operator familiarity, and affordable spare parts. In contrast, Kubota was the least common option, largely due to a deficient county-wide after-sales service (Figure 3). Furthermore, the expected lifespan is a significant consideration when County Governments select tractors, as they evaluate the long-term performance of various models bought around the same time. When County Governments select tractors, as they evaluate the long-term performance of various models bought around the same time.

Tractor Age and Replacement Considerations for County AMSs

The useful life of a farm tractor is typically 8 to 15 years with proper maintenance. However, as a tractor accumulates hours and ages, its performance may decline, making replacement necessary.

Key Replacement Factors

- Common Failures: Older tractors may frequently experience failures in components like the hydraulic pumps, clutches, and injectors, requiring attention.
- Engine Work: Tractors that reach 8 years of age may require significant engine overhaul.

Statistical Focus: Age of Tractors Owned by County AMSs

The current fleet of tractors owned by County AMSs is generally new and in its optimal operating range.

While the expected useful life of a tractor can extend up to 15 years, potential significant issues (such as major engine work, or failures in hydraulic pumps, clutches, and injectors) often begin around the 8-year mark.

Crucially, the data shows that the majority of the County AMS fleet has not yet reached this critical age: More than 50% of the tractors across all counties have been in service for less than 8 years (Figure 4).

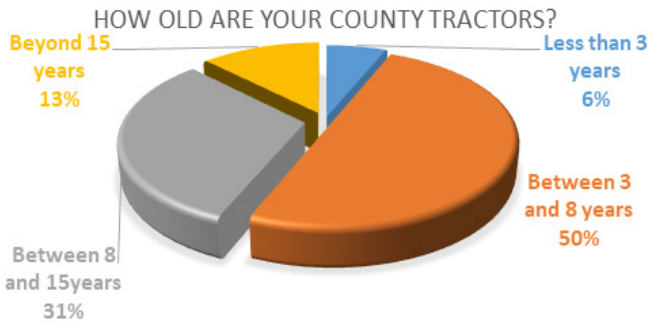

Figure 4: Average age of tractors in AMS county Schemes

This indicates that the fleet, as a whole, is currently operating appreciably within the less-than-8-year span, minimizing the immediate risk of needing extensive maintenance or replacement.

Tractor Power Ratings of County Agricultural Mechanization Services (AMSs)

Tractors used by County AMSs are categorized by their horsepower (hp) ratings, which dictate their suitability for various tasks.

Common Tractor Horsepower Ranges and Uses

- 36–50 hp: This is a common range for utility tractors. They are versatile and can handle a variety of general farm tasks, including baling, ploughing, planting/sowing, mowing, loading/off-loading, and transportation.
- 50–90 hp: These are also used as utility tractors for more demanding tasks like ploughing fields, harrowing, and weeding.
- 90–120 hp: Tractors in this higher range are suitable for heavy-duty work such as construction, industrial use, forage harvesting, and large-scale potato plantations.

Factors Influencing HP Selection

- The appropriate horsepower rating for a tractor is determined by several factors:
- Farm size
- Cropping pattern
- Soil type
- Speed and depth: Faster speeds and deeper ploughing depths require more power.

Distribution of Tractor Power Ratings

A survey of respondents regarding the tractor power ratings revealed the following distribution (refer to Figure 5):

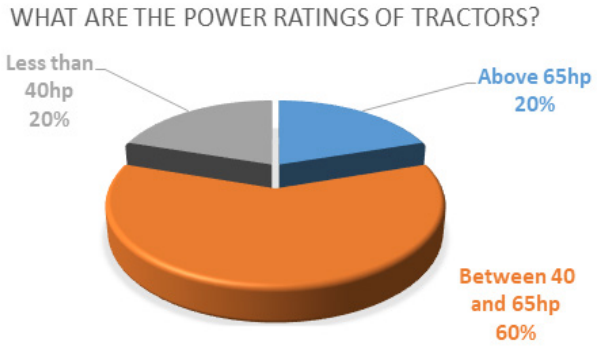

Figure 5: Tractor Power Rating

- 20% of the tractors had less than 40 hp.
- 60% of the tractors had power ratings between 40 and 60 hp.
- 20% of the tractors had a power rating over 60 hp.

Services Offered by County Agricultural Mechanization Services (AMSs)

County AMSs offer a range of tractor-hire services, with land preparation and harvesting activities being the most popular.

Most Popular Tractor-Hire Services

The most frequently sought-after tractor-hire services include:

- Land preparation (ploughing, harrowing)
- Planting
- Spraying
- Threshing
- Shelling
- Transportation

Other Available Services

In addition to the core services, tractor-hire services also provide:

- Drying
- Winnowing
- Cleaning
- Grading
- Chopping
- Milling
- Grinding

Service Provision Breakdown by County AMSs

Respondents indicated that County AMSs primarily focus on seven types of services. The breakdown of services provided is as follows:

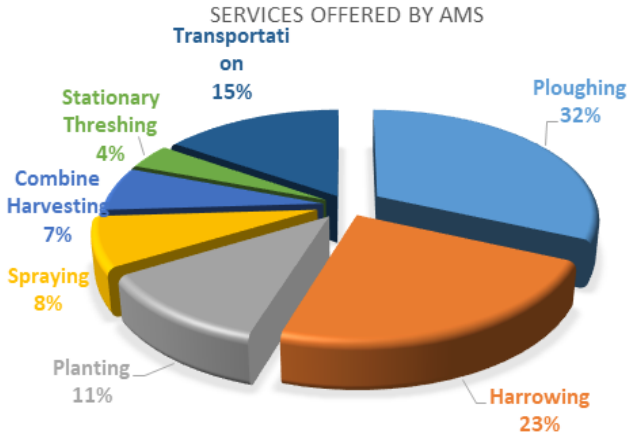

Figure 6: Services offered by County AMS

The major services targeted are ploughing (32%) and harrowing (23%), constituting the bulk of the services offered (refer to Figure 6).

The priority given to the most physically demanding agricultural jobs varies among counties, depending on the specific services each County offers.

A key finding is the limited availability of combine-harvesters in major grain-producing regions. Counties that lead in grain production-including Trans Nzoia, Uasin Gishu, Bungoma, Nandi, Nakuru, Narok, and Kakamega-generally lack combine-harvester services.
Exceptions to this scarcity are:

- Trans Nzoia
- Uasin Gishu
- Kajiado
- Nakuru

These four counties are noted to have combine-harvesters available for use.

Labor and Efficiency in County Agricultural Mechanization Services (AMS)

The labor required for a tractor hire service provider (like County AMS) is determined by the field capacity of the tractors.

$C = S \times W \times N/10$

Where:

C is Field Capacity (likely in hectares per hour or similar units, though not explicitly stated in the original text).

S is Working Speed.

W is Working Width.

N is Field Efficiency (expressed as a decimal, e.g., 0.80 for 80%).

Field Efficiency (N) accounts for non-productive time, such as turning on headlands, refueling, and filling seed/fertilizer bins (refer to Annex 3 for typical values).

Current Operational Status and Labor Distribution

The County AMS project labor force is currently distributed as follows:

Major Problem: Most County AMS are operating significantly below their expected capacity of 75%. This underperformance is equivalent to only achieving 5 hectares per week (or 20 hectares per month).

The result is that the current labor force, despite being paid salaries intended to promote food and nutrition self-sufficiency, ends up generating significant financial losses due to salaries paid against low or no production (as indicated in Figure 7).

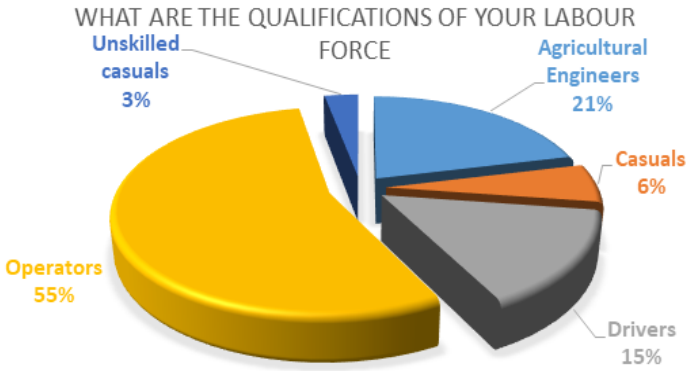

Figure 7: Qualification for workforce

Role and Benefits of a Service Shop

- A service shop is essential as it serves as a central facility for:
- Repair and Maintenance: It provides a dedicated place to repair, maintain, and store machinery, implements, and structures.
- Storage and Inventory: It is used for storing tools, supplies, and spare parts.
- Worker Shelter: It offers shelter for workers during adverse weather.

The presence of a service shop directly supports the core mission of AMS, which is to help farmers access necessary machinery and equipment for defined periods of need. This access, enabled by a functional service shop, leads to several economic and social benefits:

- Improved Productivity: It helps farm machines improve yields and complete field preparation and harvesting on time.
- Technological Advancement: It allows providers to adopt new technologies through modifications.
- Economic Impact: It helps reduce dependence on food imports and allows for the exploitation of economies of scale.
- Social Development: It contributes to creating employment opportunities and upgrading rural life.

Current Situation

Despite its vital role, 59% of the County AMS providers surveyed in the study did not have a service shop. This significant absence negatively impacts the realization of all the aforementioned benefits. Figure 8

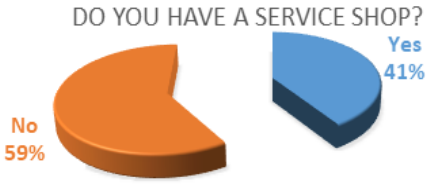

Figure 8: Service Shop

Off-Season Machine Activities

Maintenance and Preparation for Storage

The primary goal is to maintain and protect the engine and components during the storage period to ensure they remain in good condition and prevent future failure issues.

- Fluid Changes:
- Changing engine oil, transmission fluid, and coolant is crucial.
- This helps prevent sludge formation and protects the engine from corrosion and wear.
- Fuel Management:
- Emptying fuel tanks or using fuel stabilizers is recommended.
- This prevents fuel tank degradation.

Operator Activities During the Off-Season

The text also mentions how tractor hire services utilized the off-season, based on the data in " Figure. 9

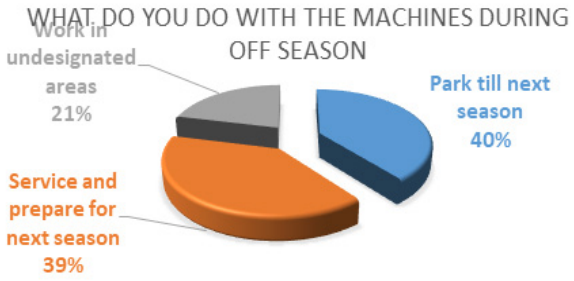

Figure 9: Utilization of off-season time for machines and labour

Average Tillage Rate per Tractor

The average acreage tilled per day per tractor varies significantly, ranging from approximately 0.8 ha to 4 ha (hectares), depending primarily on soil type.

Key Performance Factors

- Soil Type is the main determinant of a tractor's daily output:
- Light soils (e.g., Narok East, Ntulele area): A tractor can plough about 4 ha per day.
- Heavy soils (e.g., Trans Nzoia, Bikeke, Kiminini Sub-County): Performance drops substantially, with a tractor managing only about 0.8 ha per day (especially in dry conditions, such as February before the rains).
- Tilling hard, heavy soils (0.8 ha) can be extremely resource-intensive, consuming an estimated 50-60 litres of fuel for that small area.

Observed Performance Distribution

Survey respondents' daily performance (Fig. 10) indicates that most tractors operate below the maximum light-soil potential:

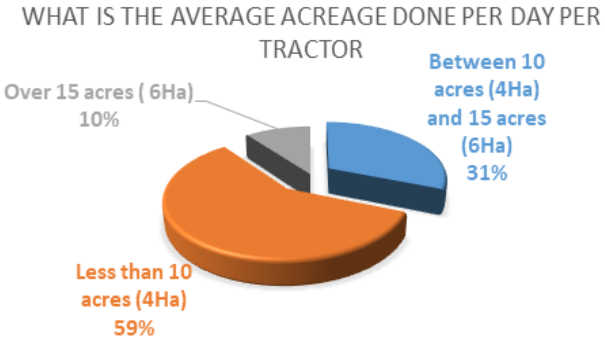

Figure 10: Acreage projection

- 59% of respondents managed less than 4 ha per day.
- 31% achieved an output between 4 ha and 6 ha per day.
- 10% reported tilling over 6 ha per day.
- 40% of operators parked all farm equipment and waited for the next season.
- 39% serviced and secured the equipment until the next season (aligning with the recommended main tenance).
- 21% sought jobs outside their county's area of jurisdiction.

Context: Varied Rain Seasons

The duration and timing of the off-season are influenced by the country's varied rain seasons:

- Some regions have one rain season.
- Most regions have two rain seasons.
- Some regions have three rain seasons.
- Not all regions utilize every rain season for farming.

Rephrased Content

Here are a few ways to rephrase the two distinct parts of your text, focusing on clarity and conciseness:

- AMS Units: Average Annual Farmer Clientele.
- Tractor Power and Farmer Service

"Figure 11 illustrates the distribution of farmers served by respondents:

- 40% of respondents served 100 farmers.
- 20% of respondents served 50 to 100 farmers.
- 40% of respondents served fewer than 50 farmers."

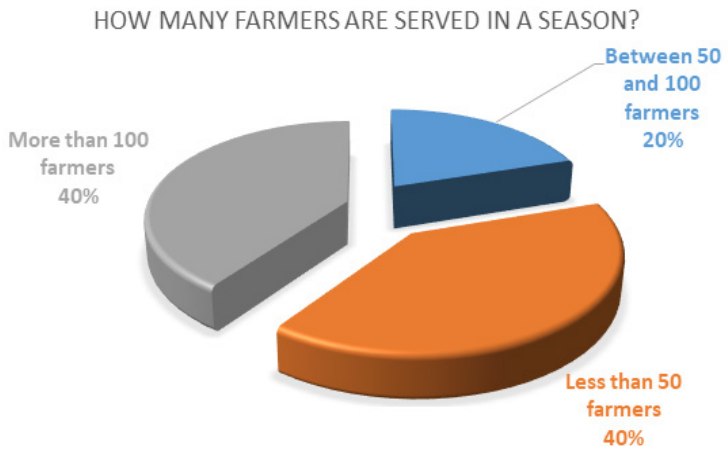

Figure 11: Farmers served per Season

Challenges in County AMS Tractor Hire Service Provision

Agricultural Mechanization Services (AMS) centers offering tractor hire services at the county level face several significant challenges:

Operational and Financial Constraints

- High Operating Costs: Centers struggle with the high cost of maintenance, spare parts, and fuel prices.
- Segregation of Land Choice: During peak seasons, service providers often selectively prioritize land based on size, terrain, and distance, potentially leaving out farmers with smaller or less accessible plots.
- Short-Term Hire Limitations: It can be difficult to hire a tractor with specific necessary features or functionality for short-term rental periods.

Human Resource and Quality Control Issues

- Operator Shortage and Qualification: There is a notable shortage of formally trained and qualified tractor operators.
- Compromised Ploughing Quality: Operators sometimes increase the plough swath to cover more acreage quickly, resulting in sections of un-ploughed land and reducing the quality of service for the landowner.
- Poor Seedbed Preparation: Inappropriate travel speed by the tractor can lead to excessive fuel consumption and deliver a poor-quality seedbed.

Communication and Transparency Deficiencies

- Limited Networking: Networking between service providers and end-users remains low, as they often lack a common digital platform, relying mainly on physical interaction for tracing and connecting.
- Information Asymmetry: Current digital tools (like mobile apps or SMS services) often fail to provide options for farmers to ask questions or visually verify the tractor's service conditions, preventing them from ensuring they receive the required service., Figure 12.

Market Structure and Competition

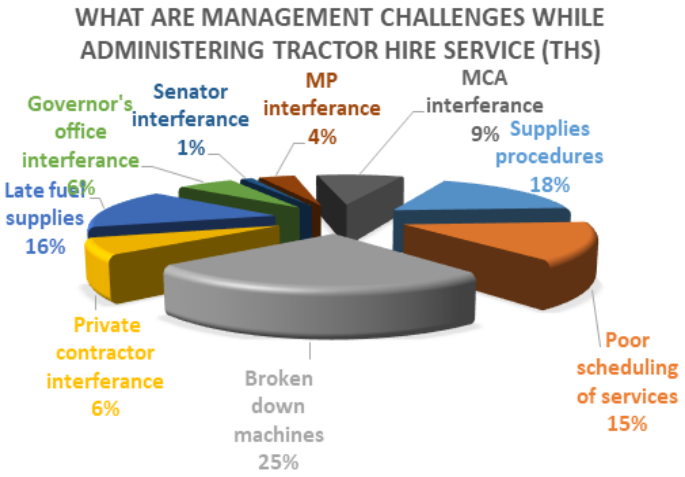

Figure 12: Management services while administering County AMS services

• Diverse Service Providers: The market structure is varied, with local farmers often providing tractor hire services in their own communities, alongside the emergence of more specialized service providers in other areas.

Actual Challenges in Kenyan Counties: Sources and Percentages

• According to the respondents, the actual challenges encountered in Kenyan counties, as illustrated in the provided data (and Fig. 12), varied significantly. The most frequently cited challenge was broken-down machinery, while political interference from local Senators was the least cited.

• Here is a breakdown of the challenges and the corresponding percentage of respondents who cited them:

Top Operational and Procedural Challenges

Challenge	Percentage (%)
Broken Down Machines	25%
Supplies Procedures	18%
Late Fuel Delivery	16%
Poor Scheduling of Service Provision	15%

Agricultural Mechanization in Kenyan Counties

The failures and challenges faced by County Agricultural Mechanization Services (AMSs) have created a niche for alternative equipment leasing services to flourish. These private alternatives, such as Hello Tractor, TingA, and e-Tinga, have learned from AMS shortcomings and entered the market offering more efficient, integrated, and professionally managed equipment services.

Key Observations on Competition and Alternatives

• Emergence of Professional Alternatives: New service providers offer complete, on-call services including tractor/equipment hire, professional operators, and reduced costs, making them the preferred choice over older AMS models.

• Efficiency and Scale: These innovative services are highly competitive, capable of mobilizing significant equipment (e.g., 10 tractors for 40 hectares in one day), reducing farmer management stress, and ultimately displacing the competition capacity of the county AMSs.

• Challenges with Unregistered Providers: In contrast to the professional alternatives, unregistered private operators often pose risks, demanding up-front fuel payment, experiencing costly and lengthy break

downs (like a broken crankshaft or failed hydraulic system), and potentially offering poor results due to over-contracting and working late hours.

Conclusion: The State of County Mechanization

Despite the significant potential of agricultural mechanization to transform farming in Kenya, its impact has been largely underestimated and poorly implemented in most counties.

- Underutilized Potential: A study based on 37 counties found that mechanization has broader agronomic, environmental, and socioeconomic consequences than is typically acknowledged.
- AMS Ineffectiveness: Most County AMS schemes are non-operational; staff are present, but equipment is frequently broken down before its expected lifespan and often vandalized.
- Need for Modernization: While the idea of county AMS is noble, realizing its potential requires a professional, modernized, and digitized business approach.
- Policy Imperatives: Drawing on FAO guidelines, the study strongly emphasizes that each county must formulate its own tailored agricultural mechanization service policy and strategy- considering its unique historical and land characteristics ensure sustainability across social, economic, and environmental fronts. Equipment acquisition must be professionally advised and matched to the workload, acknowledging that agricultural activity is year-round ("no offseason"). Hiring services may be financially superior to outright ownership for some farmers.

Table 1: Pictures

Plate 1 Bungoma | Plate 2 Bungoma

Plate 3:Bungoma | Plate 4

Plate 5:Bungoma

Plate 6: Busia

Plate 7: Busia

Plate 8:Homa Bay

Plate 9: Kakamega

Plate 10: Kakamega

Plate 11:Kilifi

Plate 12:Kilifi

Plate 13 Kitui

Plate 14: Kakamega

Plate 15: Kitui

Plate 16: Machakos

Plate 17: Machakos

Plate 18: Machakos

Plate 19: Machakos

Plate 20: Migori

Plate 21:Migori

Plate 22: Siaya

Plate 23: Migori

Plate 24:Migori

Plate 25:Siaya

Plate 26: Siaya

Recommendations for Improvement

To realize the full potential of agricultural mechanization, counties should focus on:

1. Staffing and Training: Prioritize employing qualified personnel and providing routine on-the-job training.
2. Operational Efficiency: Match equipment units to projected workload and develop profitable operational models (Recommendation.
3. Technology Integration: Use GPS for acreage estimation, and install trackers for mileage, area ploughed, and fuel consumption.
4. Business Professionalism: Run the service professionally as a business and have an operational service shop for routine repairs.
5. Farmer Engagement: Register all farmers on a communication platform for easier access to services.
6. Equipment Management: Acquire models with local back-up/after-sales service and dispose of tractors after 8 years of service.

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