



DETERMINING THE EFFICIENCY INDICATORS OF THE NEWLY ESTABLISHED FIRM TECHNICAL SERVICE POINT

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Abstract

The reliable operational condition of traction units plays a decisive role in the efficiency of agricultural production processes. During autumn and summer plowing seasons, the occurrence of technical failures in field machinery often leads to delays in agrotechnical operations, a decrease in soil moisture, the formation of large soil clods, and ultimately a reduction in overall crop yields. Therefore, the technical readiness of machinery and the promptness of maintenance services represent critical factors influencing the quality and timeliness of agricultural activities.

In the agricultural enterprises of Mingbulok district, traction units are operated intensively during the plowing season. If technical malfunctions are not detected and eliminated promptly, a considerable portion of the machinery remains idle in the field, resulting in significant productivity losses. For example, the breakdown of a single ARION C630 tractor during autumn plowing may leave 14–17 hectares of land untreated per day, which subsequently reduces soil moisture from 14–16%, complicates tillage operations, and deteriorates the overall plowing quality. When tractors are not kept in good technical condition, autumn plowing extends into rainy or snowy periods, leading to severely compromised soil structure [1]. Practical observations indicate that summer plowing yields high-quality results only when conducted immediately after wheat harvesting. If plowing is delayed



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even by one day, the soil becomes dry and dense, forming large clods and reducing the depth and uniformity of cultivation. Similarly, in irrigated fields, insufficiently maintained traction units fail to penetrate the soil at the required depth, resulting in bent or broken plow components and significant natural grain losses from mature wheat heads [2].

Due to the abovementioned challenges, the efficiency of service enterprises—particularly their ability to maintain machinery throughout the season without operational interruptions—becomes a determining factor for agricultural performance. The efficiency of technical service operations is commonly assessed through indicators such as the machinery technical readiness coefficient, service response time, service quality, cost, and the financial gain derived from uninterrupted machine operation [3].

The operational speed of regional service vehicles is also a defining factor. In Namangan region, service vehicles belonging to “Namangan SM” travel through densely populated areas, limiting their speed to 50–70 km/h, which delays service delivery to remote farms [4].

To reduce service delays and improve technical readiness, a new Firm Technical Service Point (FTSP) was established in 2023 in the Gulbog‘-2 area of Mingbulok district. This FTSP includes a service vehicle, a spare parts warehouse, and skilled specialists such as mechanics, turners, and welders. During the 2023 autumn plowing season, the new FTSP demonstrated high operational effectiveness by promptly addressing the failures occurring in the traction units of Mingbulok farms [5-15].

The primary objective of this research is to analyze the failure rates of traction units during the plowing season, calculate their daily operational reliability, and assess the practical effectiveness of the newly established FTSP based on comparative statistical indicators.

Keywords: Traction units, maintenance service, failure statistics, service points, plowing efficiency.



Methods

The study was conducted in the Mingbulok district during a 30-day autumn plowing period, focusing on 40 traction units owned by local farming enterprises. A chronometric observation method was employed to document each occurrence of mechanical failure, service intervention, repair duration, and operational downtime. This methodological approach enabled the collection of comprehensive statistical data on seasonal failure frequencies and daily operational reliability.

All failures occurring in the traction units were recorded continuously throughout the plowing season. For each machine, the following parameters were documented:

- $NM(t)$ – total number of failures during the 30-day period
- $n1(t)$ – average number of failures per day for each unit
- $q1(t)$ – probability of a unit failing in a single working day
- $P1(t)$ – probability of operating a full day without failure

These probabilities were calculated using established rules of probability theory, including the summation and multiplication of independent event probabilities.

Each failure event was classified into one of two service categories:

The FTSP mechanic repaired the malfunction directly in the field without traveling to Namangan city. This method involved the use of spare parts and tools stored in the FTSP warehouse or service vehicle.

The FTSP mechanic traveled from the Mingbulok FTSP location to the central Namangan Service Center (approximately 75 km one way) to acquire missing spare parts or specialized repair tools. This category included major engine, injector, fuel pump, bearing, and clutch-related repairs.

To assess the effectiveness of the newly established FTSP, repair statistics from the 2023 plowing season were compared with average indicators from the 2021–2022 seasons, during which no local FTSP was present and most failures required visitation-based repairs.

Descriptive statistical methods were used to summarize failure counts, repair durations, and service proportions. The following formulas were applied:

$$n(t) = NM(t) / T_m$$

$$q(t) = n(t) / N_y$$



$$P(t) = 1 - q(t)$$

Where:

$T_m = 30$ days (season duration)

$N_y = 40$ traction units

Results

The statistical analysis of field observations revealed that, during the 2023 autumn plowing season, a total of 164 failures were recorded across the 40 traction units operating in Mingbulok district. This corresponds to an average of 4.1 failures per traction unit over the 30-day period.

Based on the collected data, the average daily number of failures was calculated:

$$n(t) = 164 / 30 = 5.47 \text{ failures per day}$$

Considering that 40 traction units were operating simultaneously, the probability of a failure occurring within one day for a single unit was:

$$q(t) = 5.47 / 40 = 0.1822$$

Accordingly, the probability of operating a full day without failure was:

$$P(t) = 1 - q(t) = 0.82$$

1-Table. Number of failures per traction tractor owned by Mingbulok district farms during the season and per day, and their probabilities of failure and failure-free operation

Type and factory serial number of the faulty unit	$N_M(t)$	$n_i(t)$	$q_i(t)$	$P_i(t)$
1	2	3	4	5
A2003495	5	0,166	0,0042	0,995
A2003707	4	0,133	0,0033	0,996
A2003789	4	0,133	0,0033	0,996
A2003796	4	0,133	0,0033	0,996
A2004017	4	0,133	0,0033	0,996
A2004100	5	0,166	0,0042	0,995
A2004146	3	0,1	0,0025	0,997
A2005631	5	0,166	0,0042	0,995
A2005632	4	0,133	0,0033	0,996
A2006057	4	0,133	0,0033	0,996



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A2006062	3	0,1	0,0025	0,997
A2006068	4	0,133	0,0033	0,996
A2006074	3	0,1	0,0025	0,997
A2006085	5	0,166	0,0042	0,995
A2006086	3	0,1	0,0025	0,997
A2006482	3	0,1	0,0025	0,997
A2006500	4	0,133	0,0025	0,996
A2006930	4	0,133	0,0033	0,996
A2007066	4	0,133	0,0033	0,996
A2007073	4	0,133	0,0033	0,996
A2007098	3	0,1	0,0025	0,997
A2007219	5	0,066	0,0042	0,995
A2007701	5	0,066	0,0042	0,995
A2008300	2	0,066	0,00166	0,998
A2008302	2	0,066	0,00166	0,998
A2008323	5	0,166	0,0042	0,995
A2008397	5	0,166	0,0042	0,995
A2008457	6	0,2	0,0033	0,995
A2012003	7	0,266	0,0033	0,993
A2023094	3	0,1	0,0025	0,997
V2030282	3	0,1	0,0025	0,997
V2030347	5	0,166	0,0042	0,995
V2030593	5	0,166	0,0042	0,995
A2004018	5	0,166	0,0042	0,995
A2006010	4	0,133	0,0033	0,996
A2006088	3	0,1	0,0025	0,997
A2006287	6	0,2	0,0033	0,995
A2007220	4	0,133	0,0033	0,996
A2007700	2	0,066	0,00166	0,998
A2008083	5	0,166	0,0042	0,995
For Ny = 40 traction units	$\Sigma N_m(t) = 164$	$\bar{n}(t) = 11,413$	$\bar{Q}(t) = 0,1822$	$\bar{P}(t) = 0,82$

Before FTSP (2021–2022):

- 66% visitation repairs
- 34% on-site repairs



After FTSP (2023):

- 63 % on-site repairs
- 35 % visitation repairs

2-Table. Failures that occurred in traction units in 2023 and the proportions of repairs performed by the FTSP and by district farm mechanics

№	Type of the faulty unit		Number of failures	Repair method	
				With visit by CM Without visit by FTSP	
				With visit	Without visit
1	2	3	4	5	6
1	ARION-630C	A2008083	5	3	2
2	ARION-630C	A2003495	4	2	2
3	ARION-630C	A2003707	4		4
4	ARION-630C	A2003789	4		4
5	ARION-630C	A2003796	4	3	1
6	ARION-630C	A2004017	5	1	4
7	ARION-630C	A2004100	3	1	2
8	ARION-630C	A2004146	5		5
9	ARION-630C	A2005631	4	1	3
10	ARION-630C	A2005632	4	3	1
11	ARION-630C	A2006057	3		3
12	ARION-630C	A2006062	4	1	3
13	ARION-630C	A2006068	3		3
14	ARION-630C	A2006074	5	2	3
15	ARION-630C	A2006085	3		3
16	ARION-630C	A2006086	3		3
17	ARION-630C	A2006482	4	3	1
18	ARION-630C	A2006500	4	1	3
19	ARION-630C	A2006930	4	1	3
20	ARION-630C	A2007066	4	1	3



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21	ARION-630C	A2007073	3	2	1
22	ARION-630C	A2007098	5	2	3
23	ARION-630C	A2007219	5	2	3
24	ARION-630C	A2007701	2	1	1
25	ARION-630C	A2008300	2	1	1
26	ARION-630C	A2008302	5		5
27	ARION-630C	A2008323	5	4	1
28	ARION-630C	A2008397	6	1	5
29	ARION-630C	A2008457	7	1	6
30	ARION-630C	A2012003	3		3
31	ARION-630C	A2023094	3		3
32	ARION-630C	V2030282	5	4	1
33	ARION-630C	V2030347	5	3	2
34	ARION-630C	V2030593	5	1	4
35	ARION-630C	A2004018	4	1	3
36	ARION-630C	A2006010	3	1	2
37	ARION-630C	A2006088	6	4	2
38	ARION-630C	A2006287	4	2	2
39	ARION-630C	A2007220	2	1	1
40	ARION-630C	A2007700	5	3	2
	Overall		164/100%	57/35%	107/65%
	2021-2022 Average for (appendix)		142/100%	93/66%	49/34%

Rapid repairs conducted by the FTSP helped mitigate agronomic losses associated with delayed plowing, such as soil moisture reduction, clod formation, and inefficient tillage.

- Total failures: 164
- Average failures per unit: 4.1
- Daily failures: 5.47
- Daily failure probability: 0.1822



- Failure-free probability: 0.82
- On-site repairs: 63 %
- Visitation repairs: 35 %

Discussion

The findings of this study demonstrate that the establishment of the Firm Technical Service Point (FTSP) in Mingbulok district has had a significant and measurable impact on the technical reliability and operational continuity of traction units used during the autumn plowing season.

The FTSP reduced visitation-based repairs from 66 % to 35 %, resulting in shorter repair cycles and increased machinery readiness.

Timely repairs preserved soil moisture, prevented clod formation, and allowed plowing operations to be completed within optimal agronomic timeframes.

3-Table. Number of failures occurring in the 40 traction units owned by Mingbulok farms during the 2021–2022 autumn plowing seasons, and the proportions of repairs performed with and without visit by the regional SM mechanic

Years	Number of Failures	Repair Method	
		With Visit	Without Visit
2021	$\frac{136}{100\%}$	$\frac{45}{33\%}$	$\frac{24}{38,8\%}$
2022	$\frac{148}{100\%}$	$\frac{48}{71.04\%}$	$\frac{25}{12,5\%}$
2021-2022 Average for	$\frac{142}{100\%}$	$\frac{93}{66\%}$	$\frac{13}{26\%}$
2023 year (appendix)	$\frac{164}{100\%}$	$\frac{57}{35\%}$	$\frac{44}{80\%}$

Reduced downtime enhanced field coverage, decreased fuel and labor losses, and improved overall agricultural productivity.

Comparison with 2021–2022 shows substantial improvement in maintenance efficiency, validating the importance of localized FTSP infrastructure.



Conclusion

The establishment of the FTSP in Mingbulok district significantly improved operational reliability, reduced downtime, increased failure-free operating probability to 82 %, and enhanced the agronomic quality of plowing.

4-Table. Total time spent by the mobile workshop mechanic to repair a single failure in traction units and the average values of its components (in hours)

Number of Repairs	Repair Method	\bar{t}_T	\bar{t}_j	\bar{t}_e	\bar{t}_n	\bar{t}_y
107	FTSP mechanic did not travel to Namangan	$\frac{0.166}{3.4}$	-	-	$\frac{4.76}{96.6}$	$\frac{4.93}{100\%}$
57	FTSP mechanic traveled to Namangan	$\frac{0.16}{1.8}$	$\frac{1,9}{20.1}$	$\frac{0,6}{6.5}$	$\frac{6.8}{75.6}$	$\frac{9.5}{100\%}$

It is recommended to expand similar FTSP units across other agricultural regions to strengthen technical service delivery and increase agricultural productivity.

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