

FAILURES PATTERN OF SUGARCANE HARVESTERS IN HAKIM FARABI AGRO-INDUSTRY OF IRAN

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Abstract

The performance of sugarcane harvesters depend on function of subsystems. This paper describes failure rate and mean time between failures (MTBF) for sugarcane harvesters 7000 series which are used in HakimFarabi agro-industry of Iran. Sugarcane harvesters were divided into nine subsystems and their failures were studied for 4500 working hours. The failure rate of subsystems including engine, hydraulic transmission, topper, base cutter, chopper, feed rollers, elevator, wheels and extractor fans were calculated 0.014, 0.05, 0.023, 0.065, 0.03, 0.037, 0.026, 0.016, and 0.009 (1/h), respectively. Furthermore, MTBF for subsystems after 4500 working hours were computed 72.21, 20.26, 73.41, 15.53, 33.92, 27.25, 38.66, 61.09, and 111.85 (h), respectively for the aforementioned subsystems. Among the nine investigated components, base cutter with maximum failure rate and minimum MTBF and extractor fans with minimum failure rates and maximum MTBF were recognized the most unreliable and reliable subsystems respectively.

Keywords: failure rate, sugarcane harvester, MTBF

1. Introduction

Sugarcane is one of the main plants for sugar production. Hand sugarcane harvesting is too laborious and needs too many number of workers in long period of time; consequently, it costs a lot. Moreover, hand harvesting follows workers to injury themselves due to cutting cane by sickles. In contrast, Sugarcane mechanical harvester cuts cane and chops them into small pieces and transmits them to trailer. Many reasons related to field and crop influence the sugarcane harvester performance including soil type, soil humidity, cane variety, crop yield and operator skill (anonymous, 1999).

Whereas machine failures occur unregularly in indefinite locations of the field, manager ability to record the time, location, and the reason of failures could be diminished in process of time (kahle, 2007).

One of the most important factors to reach highest crop yield due to the lowest loss is performance on time. For machine scheduling we have to aware of its efficiency. This is impossible without exact status information from different parts of machine.

Sugarcane harvester machine as a main system consists many subsystems. The sugarcane harvester is divided into nine subsystem consisting engine, hydraulic transmission, topper, base cutter, chopper, feed rollers, elevator, wheels and extractor fans. If every one of subsystems stopped, the machine would be stopped, thus relation among harvester subsystems is series.

2.2. Failure rate

Failure rate is the scale for specify number of failures in used hours and compute from following equation (1), (Billinton and Allan, 1992):

$$\lambda = \frac{F}{H} \quad (1)$$

Where λ is failure rate, F is number of failures, and H is operation hours. By using of this function we calculated the mount of system stopping over time, and then we evaluated every one of subsystems separately.

The optimization of each subsystem in relation to one another is imperative to make the system profitable and viable for operation. Since failure cannot be prevented entirely, it is important to minimize both its probability of occurrence and the impact of failures when they occur [Barabadi and Kumar, 2008]. In order to control and reduce failure and to plan and schedule the harvester operations in optimum time, we have to know how many failures occur in each term of machine performance and how much is mean time between failures.

2. Materials and methods

2.1. Study area

Study area was HAKIM FARABI agro-industry Company located in 35 kilometers south of Ahvaz in Iran. Arable lands of this company are located in 31 to 31°10 N latitude and 45 to 48°36 E longitudes. This region has dry and warm climate. Soil of this region is heavy and semi-heavy and each farm size is 25 ha in regular forms. Totally, 24 sugarcane harvester 7000 model are being used in the company. Data are from maintenance Reports of harvesters which have been recorded since 5 years ago.

2.3. Mean time between failures

Mean time between failures (MTBF) is an appropriate scale for specifying machine performance time without any stopping. Each system consists of one or more subsystems. The components of system would be series or parallel. This system is series; it means, if due to any reason one subsystem stopped, the overall system would be stopped. MTBF for subsystems was calculated using equation 2, (Billinton and Allan, 1992):

$$MTBF = \frac{H}{F} \quad (2)$$

Where MTBF is mean time between failures, H is operation hours, and F is number of failures.

(every sugarcane harvester have worked about 900hours annually) for subsystems namely engine, hydraulic transmission, topper, base cutter, chopper, feed rollers, elevator, wheels and extractor fans were obtained 0.014, 0.05, 0.023, 0.065, 0.03, 0.037, 0.026, 0.016, and 0.009 respectively. Therefore hydraulic transmission system with maximum failure rate was the most unreliable and extractor fans system with minimum failure rate was the most reliable subsystem. Table1 shows the values of failure rates after 4500 working hours for subsystems.

3. Results and discussion

3.1. Failure rate results

Results showed that failure rate for every subsystem was different. Average failure rate after 4500 working hours for 5 years

Table 1, annual failure rates of sugarcane harvester subsystems (Every 900 hours)

Years	topper	Hydraulic	Feed rollers	chopper	elevator	Base cutter	Wheels	engine	Extractor fans
1	0.019	0.039	0.029	0.024	0.021	0.062	0.015	0.012	0.007
2	0.022	0.045	0.036	0.025	0.023	0.062	0.017	0.014	0.008
3	0.022	0.054	0.037	0.031	0.028	0.067	0.016	0.014	0.009
4	0.026	0.056	0.041	0.033	0.028	0.064	0.017	0.015	0.011
5	0.029	0.057	0.043	0.039	0.033	0.067	0.017	0.015	0.013

Figure (1) shows the failures behavior of every subsystem. Base cutter system failures were so scattered and did not follow a regular trend. These failures consisted blade breaking or blade dulling

depend on crop aggregation and material quality of blades are solved by changing the blades. Trend of hydraulic transmission system failures are increasing. Because this subsystem consist of tubes and pipes depreciating over time.

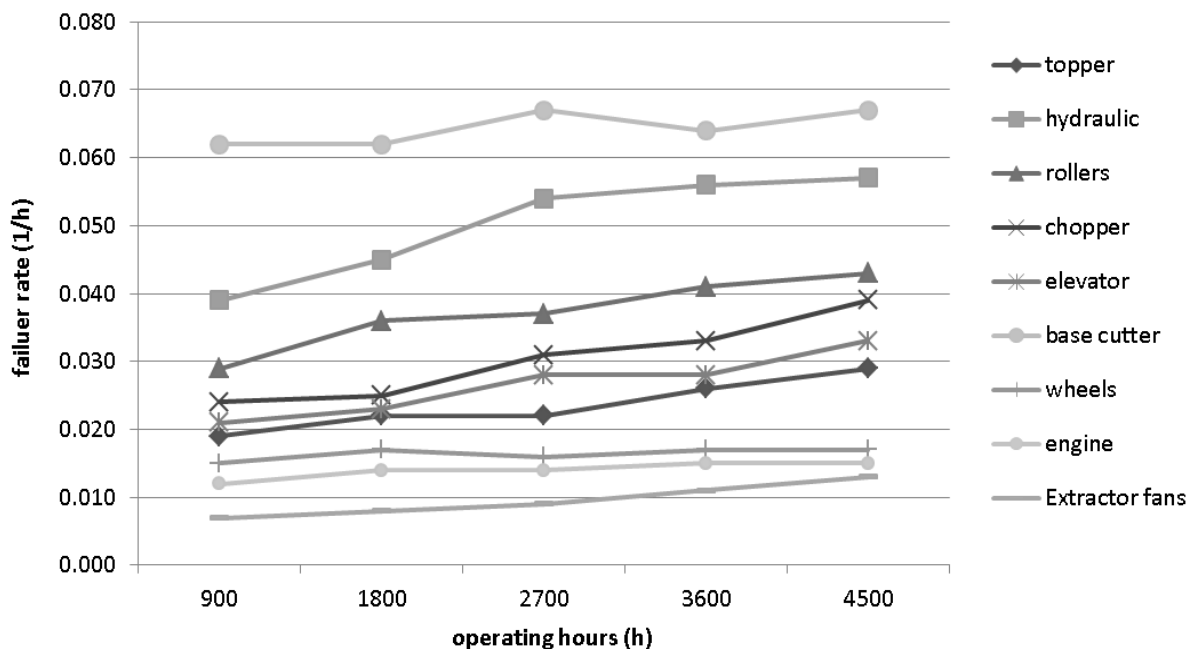


Fig 1. Failure rate of sugarcane harvester subsystems

Because of wearing of hydromotors, Feed rollers failures showed an increasing trend. Increasing failures in chopper usually are originated from blade breaking which has constant value, chopper gearbox failings, and hydromotor failings which increase over time. Elevator failures usually are from both chain obstruction due to cane bulk, and hydromotor failures that increase over time, thus failure rate graph is growing. Topper failure is as same as base cutter failure and its graph conform to base cutter graph, but with smaller failure rate. Number of wheel failures approximately is fixed, because wheel's failure is more consist of puncturing in field that is occurred fixedly Engine failures are a little and do not increase sharply. Because sugarcane harvesting never has been done in summer and at this season engine is overhauled. These failures

included of belt rupture, water pump failing and obstruction in fuel system. Fan failures increase slowly over the time.

3.2. MTBF results

The mean time between failures after 4500 hours (5 years) for sugarcane harvester subsystems presented in table 2. The average MTBF after 4500 hours for subsystems namely engine, hydraulic transmission, topper, base cutter, chopper, feed rollers, elevator, wheels and extractor fans were calculated as 72.21, 20.26, 73.41, 15.53, 33.92, 27.25, 38.66, 61.09, 111.85 (h), respectively. As a result, base cutter with 15.53 and extractor fans with 111.85 h are the most unreliable and reliable subsystems respectively.

Table 2 amounts of MTBF annually (every 900 hours)

Years	topper	Hydraulic	Feed rollers	chopper	elevator	Base cutter	Wheels	Engine	Extract or fans
1	53.9	25.5	33.9	41.7	48.2	16.1	65.5	83.3	152
2	45.4	22.1	27.5	39.5	43.2	16.2	60.5	69.8	129.7
3	45.7	18.5	27.1	32.2	36.2	15	62.1	72.4	108.6
4	38.5	17.7	24.6	30.6	35.4	15.5	59.1	68.2	88.6
5	35.	17.5	23	25.7	30.2	14.8	58.3	67.3	79.5

4. Conclusion

In order to control and reduce failure and to plan and schedule the harvester operations in optimum time, we have to

Sugarcane harvester the study was conducted in Hakim Farabi agro-industry of Iran.

The results showed that failure rate of subsystems including engine, hydraulic transmission, topper, base cutter, chopper, feed rollers, elevator, wheels and extractor fans after 4500 working hours were 0.014, 0.05, 0.023, 0.065, 0.03, 0.037, 0.026, 0.016, and 0.009,

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know how many failures occur in each term of machine performance and how much is mean time between failures. Thus, to specify the failure rate and mean time between failures of

(1/h), respectively. Furthermore, MTBF for subsystems after 4500 hours also were computed as 72.21, 20.26, 73.41, 15.53, 33.92, 27.25, 38.66, 61.09, and 111.85 (h), respectively. Therefore, base cutter with maximum failure rate and minimum MTBF and extractor fans with minimum failure rate and maximum MTBF are recognized the most unreliable and reliable subsystems respectively.