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Research Notes

Tractor   Reliability

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Reliability in engineering is defined as the probability that a device will satisfactorily perform its specified function for a specified period of time under a given set of operating conditions. Reliability is thus a mathematical expression of the likelihood of satisfactory operation. Though the repair cost of tractor is high the subsequent loss due to delay in carrying out the repair is potentially much greater than the cost of repair. Under such condition any stoppage of tractor can cause sizeable loss, due to delay in carrying out the timeliness of farm operations during the peak seasons apart from inefficient labour utilization. Hence the reliability of tractor has become more important, while the breakdown of an individual subsystem of a tractor is an annoyance (Behl *et al.,* 1987).

It is strongly believed that the application of reliability theory is feasible and necessary for proper utilisation of the tractor for time

bound critical farm operations especially when used on commercial farms.

To analyse the reliability of various subsystem of different makes of tractors, the data collected were statistically analyzed. The frequency distribution, for the above data was obtained for an interval of 200 hours from zero to a maximum value of 20,000 hours. This information formed the basis for reliability analysis. The general expression for reliability is given as

$$R(t) = e^{-\int \lambda dt}$$

Where

R (t) = reliability at any time 't' and

λ = The failure rate

The Weibull failure probability density function (PDF) is given as

$$F(t) = \int (\beta(t-\gamma)^{\beta-1/\alpha} \ e^{-(t-\gamma) \ \beta/\alpha}$$

Where

α = Scale parameter

β = Shape parameter or Weibull slope

γ = Location parameter or lower bound of life and

t = time

Integrating the above function, gives the Weibull cumulative density function (CDF) as

$$F (t) = 1 - (e^{-(t-\gamma) \ \beta/\alpha})$$

In case of tractors, the first failure can be expected as soon as the machine is placed in service and hence the lower bound is zero. Thus $\gamma = 0$, the Weibull density function becomes,

$$F(t) = 1 - e^{-t}$$
$$R(t) = 1 - F(t)$$

A program was coded for this purpose in FORTRAN language. The data related to time interval and the corresponding cumulative

failures were fed into the above program and the values obtained from the analysis were value of α, value of β, standard deviation of β and confidence limits at 35% level.

Weibull model was used to analyse the failure pattern. Weibull parameters were estimated by using the program developed. The observed and expected values for each subsystem were obtained. The developed model was tested for its goodness of fit by using Kolmogorov - Smirnov test.

The observed and expected cumulative distribution function based on Weibull model was compared. It is observed that there is no significant difference between the two and the observed and expected probability are significant at 95 per cent confidence level.

The (CDF) for engine is

$$F(t) = 1 - e^{-t3.67 / 14.1998}$$

In the same manner, the equation had been determined for all the subsystem of the tractors.

Knowing machine reliability helps in better planning for farm operation. The method allows the use of data in estimating the parameter values for the reliability function. The method developed in this study is applicable to all farm machineries. For the manufacturer, careful attention to quality and reliability during task definition, design prototype testing and production. In the future, greater emphasis should be placed on farm machinery reliability, for better functioning of farm mechanization program in the country.

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